SCIENTIFIC AMERICAN

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Vol. XCIII.—No. 8.
ESTABLISHED 1845.

NEW YORK, AUGUST 19, 1905.

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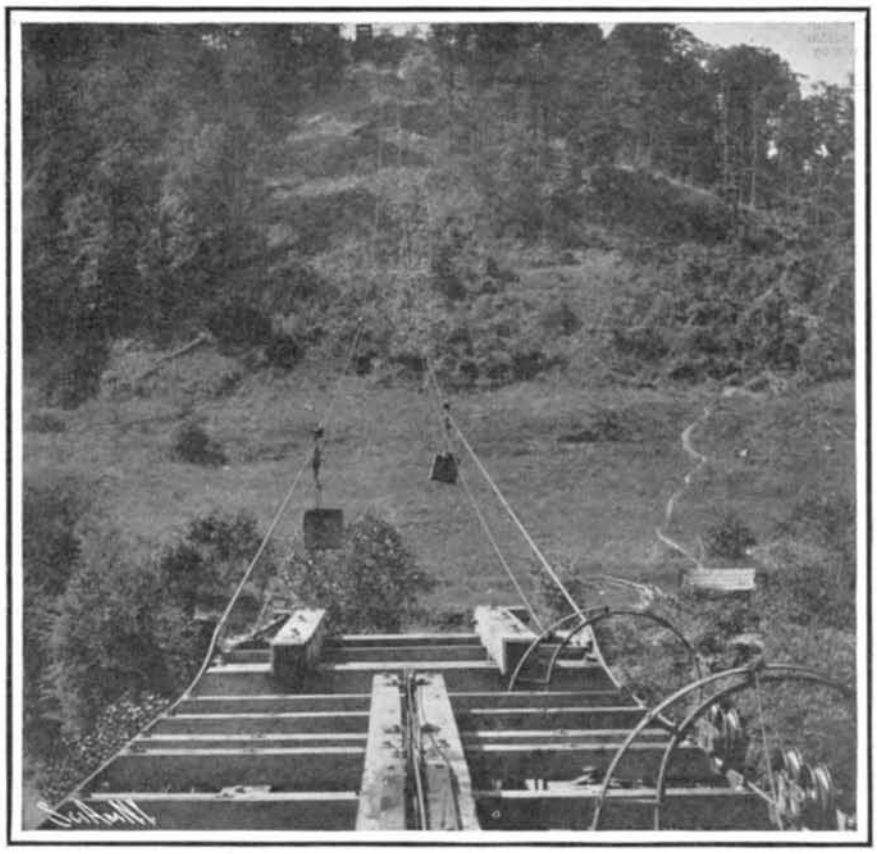
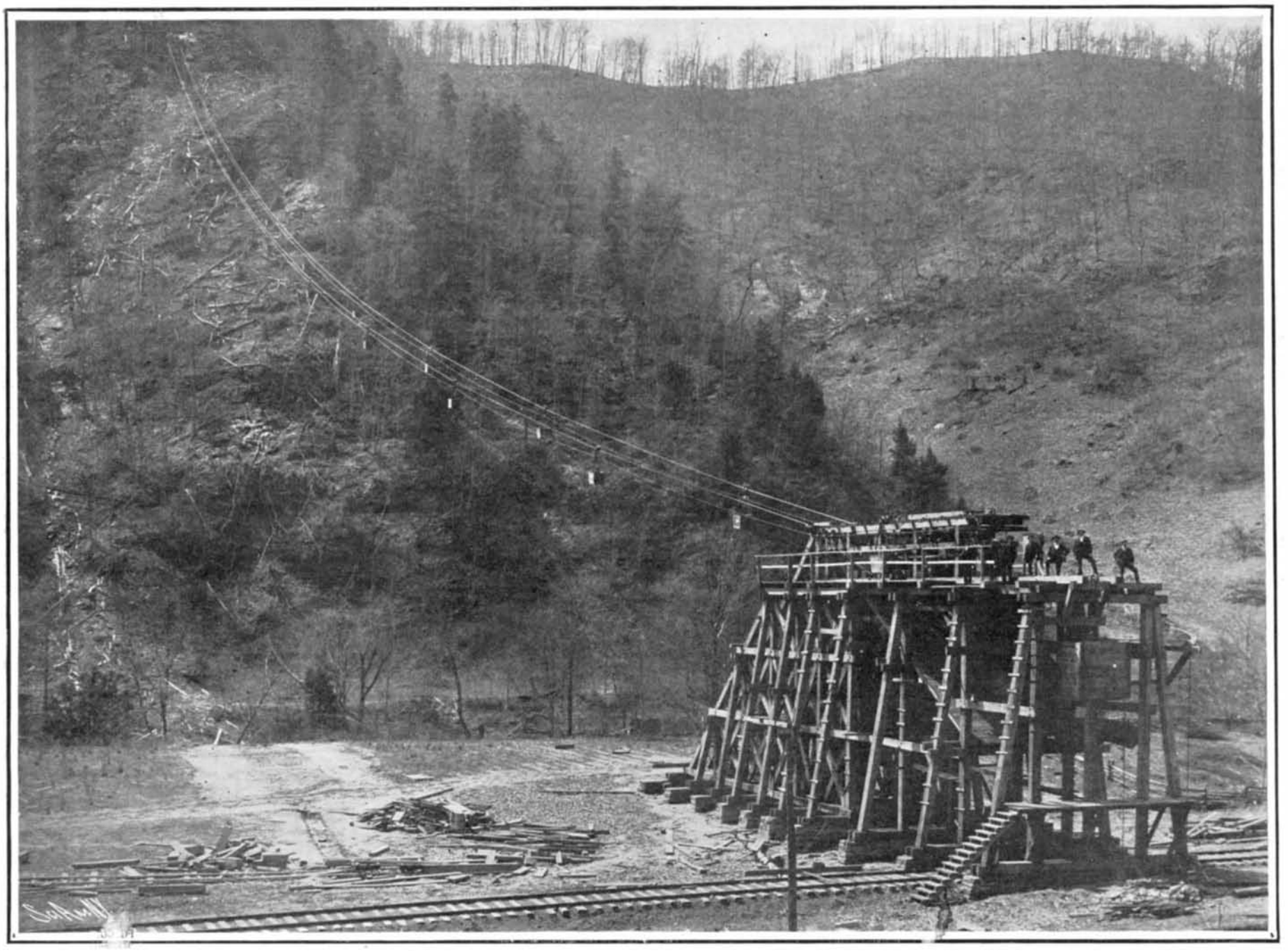
End of Tramway from Mines and Loading Chute at Headhouse.

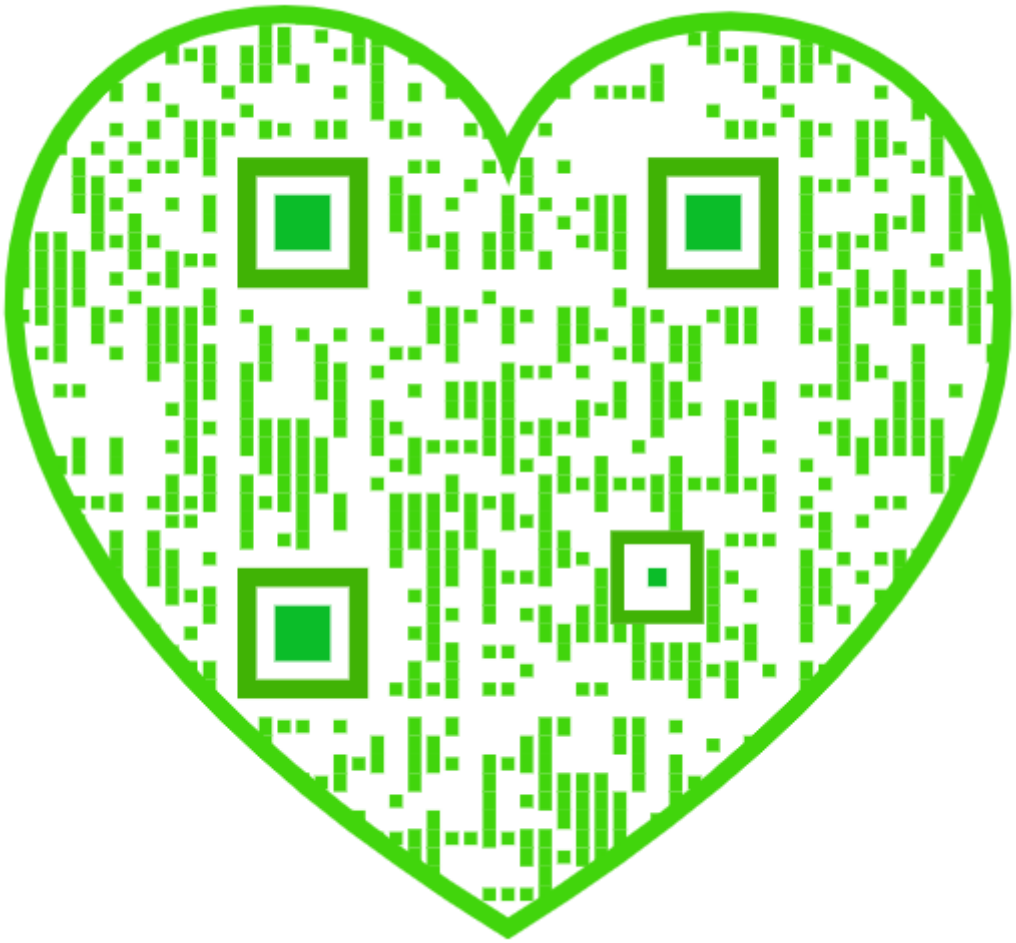


The Second Cableway Seen from the Top of the Lower Terminal.



The Sliding Carriage, Weight Box, Screen Chutes, Buckets, and Cables in Working Condition. Since This Picture Was Taken Two Additional Tracks Have Been Laid.

AERIAL TRAMWAYS IN THE TUG RIVER COAL FIELDS.—[See page 138.]



SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, AUGUST 19, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

FAILURE OF THE ISHAM SHELL.

The Isham shell, of which so much has been heard during the past few years, has at last received its quietus in a test which has just been made at the Sandy Hook proving ground. The shell was designed on the theory that, if a projectile charged with high explosive be burst by impact against the outside of armor plate, it will produce the same destructive effects that are secured when a high explosive shell is carried through the armor and burst within the interior of the ship or fortification. It was only a few years ago, as recorded in the columns of the SCIENTIFIC AMERICAN, that tests of two projectiles representing the two theories above mentioned, were made about the same time against armor plate of the same thickness, and backed up by similar structures, each representing the side of a warship. One was the present army high-explosive shell filled with maximite and dunnite, and designed to penetrate the plate and burst in the rear of it; the other was the Gathmann shell, carrying an enormous charge of high explosive and intended to burst on the front face of the plate. Gathmann believed that the mere detonation of the charge against the plate would demolish both the plate and its backing, driving it rearwardly. He claimed that if one of his shells struck the side of a warship, a large area of the ship's side would be blown bodily inward. The experts of the Army Ordnance Board believed that his theory was wrong, and advised strongly against the appropriation of money by Congress for a futile experiment. The tests were carried out and the armor plate was only slightly dished by the earlier shots and cracked through by the last. Very different were the results obtained with the army shells filled with maximite, and with other shells filled with dunnite, the charges inserted in the shells being very small, compared with those used in the Gathmann projectiles.

The shells were carried entirely through the armor and tore the backing literally into shreds, thereby giving a dramatic illustraton of what would happen in case of penetration of the thick armor of a battleship.

In the tests recently made of the Isham shell, an armored target representing a section of a battleship was set up, and the shell was fired with a velocity corresponding to the probable striking velocity at battle ranges. It exploded on contact and merely dished the face of the armor a few inches inward. The officers in charge of the tests claim that, had the plate been built into the elastic structure of a ship, the results would have been even less marked than they were.

RESCUE OF THE FIALA-ZIEGLER EXPEDITION.

The cablegram announcing the rescue of the Fiala-Ziegler expedition by one of the three rescue parties that have started during the last two years in search of the explorers, tells briefly the fate of one more of the many ill-fated attempts that have been made to solve the final mystery of the far North. The "America," which had been specially fitted and provisioned for the trip, sailed in charge of Mr. Fiala, from Trondhjem, Norway, with a complement of thirty-seven people, on June 23, 1903, for Franz Josef Land, where it was the intention to pass the winter, and set out early the next year on expeditions in dog sledges. On June 15, 1904, a relief expedition sailed from the same port, carrying provisions and general supplies; but on account of the ice and fog it was unable to reach the "America" and returned to Norway on the third of the following month. Mr. W. S. Champ, who had charge of the relief expedition, then chartered the arctic steamer, "Terra Nova," and in the following summer, on July 14 last, sailed from Tromsoe, Norway, in another attempt to find the "America." By dint of arduous labor the relief ship was pushed through until the rescue party found the members of the Ziegler expedition at Teplitz Bay, Franz Josef Land.

According to Mr. Fiala the rescue was timely, the expedition having been cut off from all communication with the outside world for two years past. The "America" wintered in Teplitz Bay where, early in the winter of 1903-04, she was crushed by the ice and became a total loss. Fortunately the party found the large supplies of stores which had been left at Franz Josef Land by various relief parties. Three separate attempts were made to reach a high latitude, but they all failed.

As far as the interests of geographical knowledge are concerned, the expedition must be regarded as a distinct failure, the farthest north recorded being 82 deg. 13 min. As early as the year 1827 Parry had reached the same latitude. So did Aldrich in 1875; while Markham, Lockwood, and Peary all attained higher latitudes than this. The farthest north was made by Nansen, with a record of 86 deg. 14 min. in 1895, and the Duke of Abruzzi, who reached 86 deg. 33 min. The cable dispatches announce that the scientific work that was planned for the expedition was successfully carried out by Mr. W. J. Peters, of the United States Geological Survey.

It should be stated that yet another relief expedition, headed by Dr. O. L. Fassig, of Johns Hopkins University, left London in May in the arctic steamer "Belgica," taking the Greenland route. A message was received from the expedition on August 7, stating that no member of the Ziegler expedition had been seen.

BIDS FOR THE MANHATTAN BRIDGE.

Over two years ago the Bridge Commissioner of this city asked the Board of Aldermen for the necessary appropriation for the construction of the greatly-needed Manhattan Bridge, across the East River. The Board flatly refused to make any appropriation, and, as a consequence, New York city has been subjected to two years of needless delay and untold discomfort. The present bridge engineer, who was responsible for the delay, has designed, or caused to be designed, a new structure, bids for which have only recently been called for. The lowest of the five bids that have been received was $7,255,000 for the superstructure steel work, and this was made by the firm that built the approaches and the suspended roadway of the Williamsburg Bridge. It now becomes possible to compare the cost of the new design with that of the design that was rejected, and the probabilities are that the new structure will prove to be the more costly and that it will take from a year to a year and a half longer to build. If this should prove to be the case (we hope to take up this matter in fuller detail in a later issue) New York city will have had another object lesson in the supreme folly of allowing its municipal engineering works to be made the sport of politics. It begins to look as though, by the time this bridge comes to be opened, which will certainly not be earlier than the year 1910, New York city will have paid the penalty of three or four years' delay and several million dollars expense for which the public at large will receive no compensatory return whatever.

ELECTRIC LOCOMOTIVES FOR THE NEW YORK CENTRAL.

In recent issues, both of the SCIENTIFIC AMERICAN and SUPPLEMENT, we have given illustrated articles on the subject of the elaborate tests that have been made by the New York Central Railroad of an experimental electric locomotive, designed for handling the express traffic within a radius of 35 miles of the New York terminal station. These tests have been carried out on a six-mile stretch of track on the main line of the company's system, west of Schenectady, and they have now been continued steadily for such a long period of time, that the engine may be said to have experienced practically every conceivable condition of weather, load, and track. The data gathered in this way are so eminently satisfactory, that the company has placed orders for electrical equipment, which are said to aggregate over $6,000,000 in value. The order includes thirty-five electric locomotives for the through express service, and 175 cars which are to be used in the suburban service. Each of these engines will weigh about 95 tons and will develop normally 2,200 horse-power, although this amount can be exceeded when it is necessary. They will be carried on eight 44-inch driving wheels, all coupled. Although the draw-bar pull considerably exceeds that of the most powerful steam express locomotives of the day, the concentrated load on the drivers will be considerably less than that on steam locomotives. Each engine will be able to haul at schedule speed a train of about twelve cars, equivalent to a load of about 500 tons. The electric locomotives will be coupled to the main line incoming express trains at Croton, where there will be a running shed and shop conveniences for both the steam and electric locomotives. The expresses will be run into and brought out from New York city entirely by electric power. The same conditions will prevail at White Plains, twenty-five miles out from New York city, on the Harlem division, where the steam locomotives will be uncoupled and the electric locomotives will take their place. It is expected that this equipment will be ready for work within the next twelve months, by which time sufficient progress will have been made with the change of tracks to admit of a partial use of the electrical service.

RAILROAD AND OTHER ACCIDENTS IN THE UNITED STATES.

Accident Bulletin No. 15, of the Interstate Commerce Commission, opens with the following statement: "The number of persons killed in train accidents during the months of January, February, and March, 1905, as shown in reports made by the railroad companies to the Interstate Commerce Commission, under the Accident Law of March 3, 1901, was 232, and of injured 3,713. Accidents of other kinds, including those sustained by employes while at work, and by passengers in getting on and off the cars, etc., bring the total number of casualties up to 909 killed and 14,397 injured." There is probably nothing in all the current literature of the day that the railroad companies dislike quite so much as the modest little pamphlet, published quarterly, from which the above quotation is taken. They claim that the bald statement of losses and injuries, as presented in these bulletins, gives undue and misleading prominence to what, according to their point of view, is merely a detail of the vast operations of our railroad system. They claim, with perfect propriety, that the total number of accidents should be considered in relation to the total number of passenger miles.

During the past few months the technical journals that are specially devoted to railroads have taken up the question from the railroad company's point of view, and are attempting to mitigate the horror of our casualty list by pointing to the enormous number of passengers that are carried without any mishap. The question, however, is not how many do we carry, and how many do we kill, but rather how does the proportion of killed and wounded to total number carried in the United States compare with the proportion of killed and wounded to total number carried in other countries. As everyone knows, the proportion is notoriously larger in the United States.

One of our contemporaries, however, raises an excellent point when he claims that the undue prominence given to railroad accidents is due to the fact that accidents through other means of travel are not officially recorded by the government. The same journal asks whether it would not be advisable to have other commissions appointed to collect and have power to enforce the submitting of statistics of electric railway and street railway accidents, and accidents through the growing use of the automobile. We are so far in agreement with our contemporary that we think immediate steps ought to be taken by Congress to appoint such a commission and empower it to collect statistics of accidents as complete as thos furnished to the Interstate Commerce Commission.

Particularly is it desirable that statistics of automobile accidents should be reported and classified in quarterly bulletins. We are satisfied that were statistics available for the whole of the United States, the total number of killed and injured would prove so large as to cause a thrill of horror to pass through the whole nation. Both the general public and the owners and drivers of the automobiles themselves, require the protection that is undoubtedly afforded by governmental supervision of accident statistics. Considerations of humanity alone should prompt Congress to take up this matter as a question that is assuming national importance.

BOMBS FOR HAIL IN SWITZERLAND.

In a note which he recently presented to the Académie des Sciences, M. Vidal shows the efficacy of the new hail-destroying bombs which he has invented. On the first of August of last year, a severe storm which was condensed on the highest summits of the Bernese Alps at altitudes above 10,000 feet, came down through the narrow valley of the Rhone. With great speed it passed across the northeast end of Lake Leman, over the rich plains of the Vaud canton, then ended at the Lake of Neuchatel. All the localities were much damaged by hail, except the small towns of Lonay and Echichens. These were the only places where the bombs were fired into the air, and this seems to be a good proof as to the efficacy of this means of preventing hail. Besides this, M. Vidal brings out a point in meteorology discovered during the storm and hitherto completely unobserved. The clouds seemed to have been banked in, and were only allowed to follow a certain path. It is remarked that all the localities which lay higher than 2,200 feet altitude escaped damage by the storm. We thus have a valuable indication as to the height of the storm-clouds, and it seems certain that they kept at a very short distance from the ground. He considers that even when formed at a high altitude in the upper layers of the air or on the snow-covered tops of mountains, the storms tend to approach the soil, and the more so as they are more highly charged with water or hail. It is due to the low altitude that the rockets and bombs against the hail are so effective. They are easily fired, and explode

in the air at 1,200 or 1,500 feet altitude. He proposes the study of the map so as to find the habitual paths of storms, then to place advance guard posts which protect a certain region by firing the bombs and prevent the rain from changing to hail. The question of protection against storms is a scientific problem and the official observatories could greatly aid in the solution, which is so important in the agricultural districts.

INVENTIONS OF ANCIENT ROME: SOME FORERUNNERS OF MODERN INGENUITY.

BY ALEX. DEL MAR, M.E.

The mechanical and other inventions of the Romans, whether original with themselves or borrowed from the nations they conquered, were so numerous that, in order to describe them, first with the object to note how largely we are indebted to antiquity for the devices now in common use, and second, to derive from these inventions such practical advantages as they may suggest—for some of them yet await adoption—it is necessary to divide and classify them. In this arrangement, the inventions pertaining to agriculture naturally take precedence over all others.

Pliny's boast that "the Roman people has never shown itself slow to adopt all useful arts," is not without a substantial basis of truth. The notion which has been advanced in modern times, that the Romans were steeped in bloodshed, tyranny, and voluptuousness, is altogether erroneous. They were a warlike and pleasure-loving people; but they were also hard-working, industrious, and inventive. The number and prominence of their agricultural publications alone afford ample evidences of their industry. After twenty centuries of social cataclysms, we still possess the treatises of Cato, Varro, Columella, and Pliny, to say nothing of the bucolic almanacs of Ovid, Virgil, Manilius, and others.

One of the most important inventions or adaptations of the Romans was the two-course system, begun with cultivating the land and letting it lie fallow in alternate years, and ended with sowing it alternately with cereal and root crops. The specialization of guano was carried so far as to value the manure of thrushes, pigeons, and domestic fowls and other animals, in the order named. The sowing machine or seed drill is doubtfully credited by Beckmann to Theophrastus; at all events, it is plainly described by Pliny, who also mentions the Rhaetian (Swiss) wheel plow. His measure of a fair day's work for a yoke of oxen for the first plowing, nine inches deep, is an acre, and for the second plowing, an acre and a half; with the wheel plow, about two acres. The machine reaper was another Roman invention. With the scythe, an acre of grass was a fair day's work; with the scythe-chariot, or reaping-machine, four times as much. The grain harvester was a Frankish invention. "In the vast domains of Gaul, a large hollow frame, armed with teeth and supported on two wheels, is driven through the standing corn, the beasts being yoked behind it; the result being that the ears are cut off and fall within the frame." The wine press, which anciently was worked by levers, was much improved by the Greeks during the Augustan period, by adopting the screw. About A. D. 50 this press was still further improved by the Romans, who used thicker plank, reduced the size of the press boards and the height of the screw, and gave the latter more threads.

The city of Rome was supplied with no less than fourteen aqueducts, not necessarily for drinking purposes, because it always had the river, which afforded a copious flood of fresh water, but for the sake of convenience, and especially to supply the baths and drive the water mills, most of which were located under Mount Janiculum. It was these water mills which made Rome a great manufacturing city. They were employed in innumerable arts, and gave rise to endless mechanical inventions and improvements. When, in the sixth century, the Goths laid siege to Rome and cut off the aqueduct water, Belisarius established a series of floating boat-mills on the Tiber, which, being driven by the current, enabled the accustomed industries to be resumed. Grist mills driven by streams, or the wind, were common in the rural districts; the more ancient ones pounding the corn in gigantic mortars, the improved ones grinding it between revolving stones. Not only was flour produced in these mills, but also various cereal preparations, like our breakfast foods of the present day. Among these was one that yet remains to be reinvented. This was alica, a preparation of spelt, which the Roman writers allude to as a great delicacy.

It is not many years since the yeast cake was introduced into America as a novelty; yet it is an invention at least two thousand years old. Here are the words of the Roman encyclopedist on the subject: "Millet is more especially employed to make yeast. If kneaded with must (grape-juice) it will keep a whole year. The same is done, too, with fine wheat bran of the best quality. It is kneaded with white must, three days old, and then dried in the sun, after which it is made into small cakes."

The cultivation of alfalfa, which has made the fortunes of some of our far western farmers, is another "antiquity." It was brought from Media into Persia in the time of Darius, and afterward into Greece and Italy. Medica was its Persian, lucerne its Italian, and alfalfa its Arabian name. Amphilocus, an agricultural writer of Athens, devoted almost an entire work to the culture of this valuable grass; and the Roman writers were scarcely less enthusiastic on the subject.

The silo, for preserving grain in the earth, is evidently an Oriental invention, which, before the Augustan age, made its way westward through Bactria, Pontus, and Thrace to Egypt, Greece, Italy, and Spain. The Pontic name was *siri*. Varro says that wheat, properly stored in dry soil, will keep for fifty years; and millet, a hundred. He mentions an actual instance of beans, which were preserved for a period of more than 220 years.

The same ingenuity that could preserve grain from rotting, protected wood from burning; and this also was a Pontine and perhaps an Oriental invention. Aulus Gellius relates that at a period about a century before the Christian era, Archelaus, one of the generals of Mithridates, painted a wooden tower with a preparation of alum, and thus rendered abortive Sylla's attempt to fire it. Another method of protecting wood from fire is mentioned by the Greek tactician, Æneas, about 360 B. C. The Greeks also invented our roof gardens, and have left us very explicit directions how to construct them. The idea was doubtless taken from the hanging gardens of Babylon, while these again probably came from the Orient. But few things are entirely new. Roof gardens are as much an evolution as steam engines. They both saw the light in halcyon ages; were neglected or forgotten in times of retrogression; and were resurrected, with improvements, in more propitious days.

If now we turn from mechanical inventions to the agricultural products of the Roman period, especially those which are believed to be of modern introduction, we will find among the number esparto, silk, cotton, glucose, champagne, lard, and possibly tobacco. There will probably be no question about the first half dozen of these commodities; the disputable subject is tobacco.

Esparto, which is still largely used in Southern Europe for making sandals, mats, baskets, ropes, nets, sacks, etc., and which for similar purposes might be profitably cultivated in the United States, was known to the Romans as spartum. It was brought from Asia by the Carthaginians, and introduced by them into Spain during the fourth century B. C. At about the same time it was also cultivated in Greece, and employed in making the rigging of their light sailing craft. From these countries it spread to all the intervening ones. The story that the silkworm and the manufacture of silk were introduced into Europe by two monks, in the reign of Justinian, is unworthy of credit. Silkworms were cultivated in the Greek island of Cos nearly a thousand years before Justinian; and a tissue was made from their silk, which was then, as now, known as bombazine. The fact is mentioned by Aristotle and corroborated by Pliny, who remarked that the clinging garments made of it, disclosed almost as much as they concealed. The gossypium, or cotton plant, and manufacture, are fully described by the same author, who, after alluding to the culture of the plant in Egypt, says: "There is no tissue known that is superior to this thread, either for whiteness, softness, or dressing; the most valuable vestments worn by the Egyptian priests being made from it." To confirm his account, abundance of cotton tissues have been found in Egyptian tombs of the Alexandrian age. Glucose, known to the Greeks by nearly the same name, *ai gleucos*, or Always Sweet, and to the Narbonenses as *dulce*, or sweet, was gathered from raisins. "In order to make it," says Pliny, "they keep the grape hanging on the vine for a considerable time, taking care to twist the stalk." In many parts of Europe it is still made in the same way.

When we speak of champagne, it is neither cider, mead, nor perry that is meant, all of which were manufactured by the Romans, and are fully described in the works left to us; but of a wine made from grapes, and rendered sparkling and effervescent by artificial means. "As to wines which have been treated with marble, gypsum, or lime, where is the man, however robust he may be, who has not stood in dread of them?" inquires a Roman moralist. What is this but champagne? Strange as it may seem, this too appears to have been an Oriental invention; for previous to the Roman imperial era, both the Greeks and Egyptians had it. In Africa, says Pliny, it was prepared with gypsum or lime, and in Greece with powdered marble, precisely as is done in many countries at the present day.

Hog lard is invariably referred to by the Greek and Roman writers as *axungia*, or axle grease, that probably being its principal use in countries blessed with an abundance of pure olive oil. It was also largely used for ointments, unguents, and pomades.

It will not be disputed that the culture of tobacco was brought into Europe from America in the sixteenth century; what is contended is that the smoking of pipes is of great antiquity, and was practised in India, China, and Egypt, long before the discovery of America. Pliny mentions the smoking of colt's-foot, "inhaled through a reed," as a cure for a chronic cough. Apollodorus, a writer of the Ptolemaic age, says that: "The barbarians, by inhaling the fumes of the cypiros plant, diminish the size of the spleen. They never go out of the house," he adds, "till they have inhaled these fumes, through the agency of which they acquire strength and vigor." Pliny calls cypiros an Indian weed; says it resembles the ginger plant; that some people chew it; and that it tastes like saffron. All of which certainly suggests tobacco. If the Indian traders of Ptolemy could introduce it no farther west than Egypt, and Oviedo first introduced it from America into Spain, it took nearly two thousand years to carry it from one to the other of these distant frontiers of the empire. It would be a curious subject to inquire what pantascopic changes its soothing influences might have brought about, had the Romans encouraged its use during the interval!

SCIENCE NOTES.

Action of Liquid Air on the Activity of Seeds.—In a memoir read before the Académie des Sciences, M. Paul Becquerel publishes the results of his investigations on the action of cold on seeds, making use of liquid air. The interesting conclusion is reached that the resistance of seeds at low temperatures depends on the quantity of water and gas contained. If the quantity is sufficient, the cold disorganizes the protoplasm and nucleus and renders all return of life impossible. But if the protoplasm has already reached by desiccation its maximum of concentration, or maximum of activity, it escapes the influence of low temperatures, and the seed preserves its germinating power.

Within comparatively recent years, that is, since aniline dyes have almost completely supplanted the mineral and vegetable dyes formerly used in coloring cotton textiles, an extensive demand for castor oil has sprung up in the industry of dyeing and printing cotton goods. Without presuming to invade the intricacies of the dyer's art wherein secret recipes for the composition of colors and their application to cloth are the property of each individual dyer, it may be said that the general principle underlying the utility of this oil in coloring processes is that the aniline and alizarine dyes are soluble in sulphurated castor oil; in other neutral fats and oils these dyes, with few exceptions, are in general insoluble. In certain processes of dyeing and printing, therefore, castor oil enjoys a practical monopoly over all other oils.

The sphere of hygiene may be divided, as it often is, into the two hemispheres, public hygiene and personal hygiene, or it may be cut into one portion dealing chiefly with the human mechanism and its operation (personal hygiene), and another portion dealing chiefly with the environment of that mechanism (sanitation). The time has gone by when any one person can safely undertake to deal with the whole sphere of hygiene. The physiologist and the physician must in the future leave to the architect and the sanitary engineer such subjects as: housing, heating and ventilation, water supply and sewerage, precisely as the sanitary engineer has never presumed to deal with foods and feeding, vaccines and antitoxins, exercise, sleep and rest. The former subjects deal chiefly with the control of the environment, the latter subjects chiefly with the control of the individual, and sanitation and hygiene must henceforward be regarded as separate hemispheres of the science of health.

A new apparatus, the "aquameter," has been devised for assisting in the compilation of weather forecasts. In such work it is pointed out that a very important factor is not taken sufficiently into consideration. This is the exactitude of the percentage of aqueous vapor in the approaching winds. The barometer gives some such indication, but the height of the barometer depends on wind pressure and temperature as well as on moisture. The wet and dry-bulb thermometers constitute an antiquated instrument and are not sufficiently reliable, as their variation depends on erratic circumstances and their indications are not represented in actual percentages of aqueous vapor. Rain results when an atmosphere nearly saturated with aqueous vapor becomes lowered in temperature. The nearness or otherwise of a wind to its saturation point, is, therefore, a most important question. It has had to be determined hitherto by recourse to elaborate apparatus, including a chemical balance, and, therefore, out of the usual province of a meteorologist. By using the aquameter, however, which is a simple instrument, the exact percentage of aqueous vapor can be obtained. By the opening and shutting of two taps and the raising and lowering of a mercury reservoir, a measured quantity of air is drawn into a glass vessel, and placed in contact with anhydrous phosphoric acid which is a rapid water absorbent. The rise of mercury in the narrow glass stem of the vessel then gives the exact percentage of the aqueous vapor in the air.

HYDRAULIC MINING WITH CENTRIFUGAL PUMPS.

BY ENOS BROWN.

The first attempt ever made in the State of Oregon to exploit an extensive gold placer deposit by artificial power has been recently given a successful trial at Grant's Pass, a city in the southern part of the State just north of the California line. The employment of "giants" in hydraulic mining was first introduced in California, and by this means enormous quantities of gold, in the aggregate, have been saved from deposits where values were too low to justify mining by any other process.

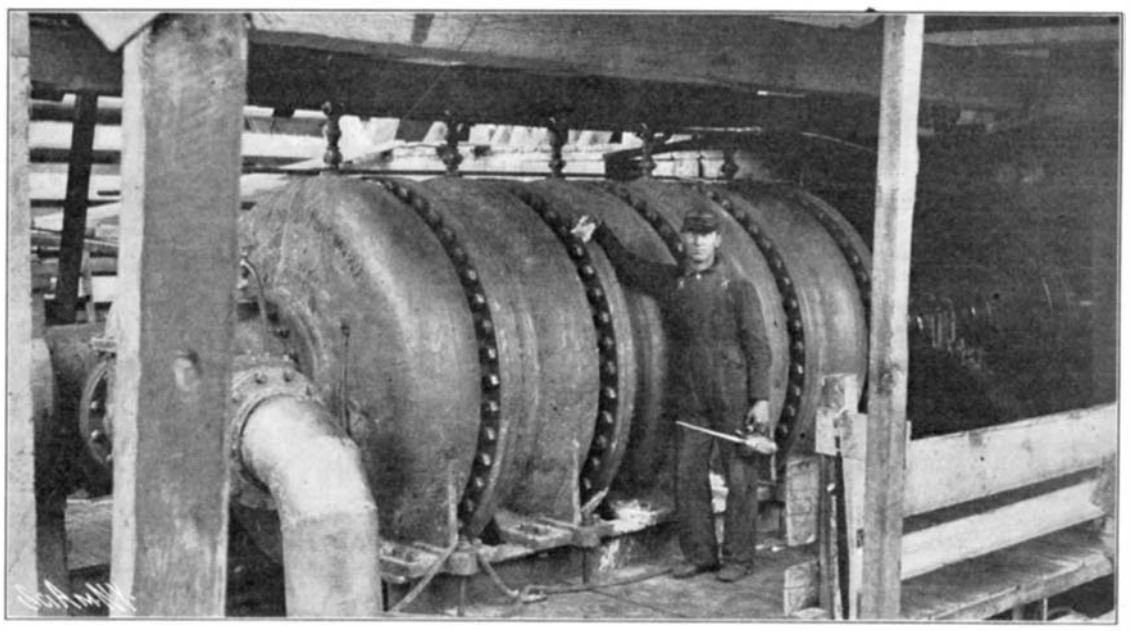
In the vicinity of Grant's Pass there are thousands of acres of rich placers which have never been worked extensively, owing to their high elevation above the surrounding country and the difficulty of installing a water supply, the hydraulic method being the only one by which the deposits could be profitably worked.

Rogue River is a stream which rises in the high Sierras and is fed from inexhaustible banks of snow. It is at all seasons of the year of large volume; but its bed lies at a depth of 430 feet below the placer deposits referred to. Surveys have been made from time to time, with the object of damming the river in higher altitudes and conveying water to the desired point through pipes and by gravity; but although such a scheme would be practicable, the expense would be very large and hardly justified by anticipated results, especially when the engineering obstacles that had to be surmounted were considered. It would be necessary to travel far to find so large an extent of country, as irregular in its contour, or rough in character, as this portion of the State of Oregon. The first expense of a pipe line, therefore, together with the inaccessibility of the region and the probability of accidents, rendered its construction exceedingly difficult. The alternative, if gravity could not be employed in developing the placers, was in utilizing the power at hand in Rogue River, which never flows less than 144,000 miner's inches and has close at hand an easily developed fall of 20½ feet.

To construct a dam and install the necessary turbines was an easy proposition as well as a comparatively inexpensive one. The main, and in fact the only, difficulty to overcome, lay in finding a pump of adequate strength and capacity to withstand the great pressure to which it was to be subjected in raising a quantity of water of not less than 9,000 gallons per minute to a height of 430 feet. The work demanded was continuous. Like the flow of the river, the pump was required to run day and night from one year's end to the other. The design and construction of the pumps was undertaken successfully by the Byron Jackson Machine Company, of San Francisco. Confident of the result they assumed all risk and responsibility and have just completed the installation of one of their five-step centrifugals with very successful results. The first unit has been in continuous operation for over three months.

The power generated by the Rogue River is capable of driving four units of four turbines each. One unit has been installed. The turbines are of the ordinary vertical-draft tube type of standard pattern. The heavy gearings are seated on I-beams on the pump deck. The turbines convey their power by transmission gear to a line shaft tapering from 7 to 6 inches, directly connected to the pump by flexible couplings. Each unit of four turbines will operate one pump. The pump of the Byron Jackson Machine Company is an 18-inch five-step centrifugal, weighing over forty tons, resting on heavy steel I-beams and securely anchored to a concrete foundation, 4 feet in depth. The main pipe-line from the pump is 1,500 feet in length by 22 inches in diameter, attaining a vertical height of 150 feet in that distance. Distribution to the giants is made at the point of greatest elevation. The pump is guaranteed to supply three giants through a 3-inch nozzle at 360 revolutions. So far but two giants are in operation, the pressure on the pump at this duty not exceeding 160 pounds. With the centrifugal a steady head is maintained at the nozzles by direct connection with the main line from the pump. The total volume of water pumped in 24 hours is 13,000,000 gallons and this amount has been continuous from the time when the power was first applied.

"Giant" in Operation, Throwing Stream 250 Feet.



A Five-Step Series Centrifugal Pump.

The Pipe Line from the Pumps to the "Giants."

HYDRAULIC MINING WITH CENTRIFUGAL PUMPS.

For the benefit of engineers a technical description of this pump is annexed.

The water enters in the suction elbow on the shaft side of the pump case. At that end the pressure is only that which can be created by vacuum; and for practical purposes this amounts never to more than twenty inches.

The pump is so constructed that none of the stuffing boxes in any part of it is subjected to the discharge pressure due to 430 feet head. It may be well realized by engineers and mechanics that it is difficult to make a tight joint under such heavy hydraulic pressure. The water enters the center of the first runner and is discharged from the ports of the same at a tangent and its energy is converted into pressure head in the whirlpool space. Properly curved water vanes are inserted between the first and second runners, guiding the water in a continuous stream without eddies to the center of the next runner, and the operation is continued until the final fifth step is reached, so that each runner takes care of one-fifth the total head for which the pump is pumping, and it is shown by gages placed on the different chambers that the pressure increases in an exact geometrical progression.

This particular pump was built with the view of limiting the speed to 360 revolutions in order to prevent a too great velocity of the bevel gears, which drive the same, there being mounted four sets of bevel gears, one for each of the vertical turbines which supply the power for the pump.

If the arrangement had been designed so that the pump could have been directly connected to horizontal turbines, and if a speed considerably in excess of that under which the pump is operating had been obtained, it would have been easily possible to produce the necessary head of 430 feet with three or even two steps instead of five. The pump was tested under 250 pounds working pressure equal to a static head of 577 feet.

In view of the heavy column of water resting on this pump, the perfection with which the balancing of this pump against end thrust has been secured is certainly remarkable. Owing to the automatic water balance with which it is furnished the pump seems to run perfectly free. Such a result could never be accomplished by means of a metal, or even a ball step bearing.

The success of the plant described is complete. It is intended to increase the output by installing three additional units of turbines and centrifugal pumps by which a surplus for irrigation, light, and power will be generated and distributed to the surrounding country. The monthly running expense, including all labor connected with running of pump, giants, sluicing, etc., is about $1,500.

Owing to structural instability it has been decided to rebuild the "Auld Brig of Ayr," immortalized by the poet Burns. The characteristics of the bridge, which dates from the end of the fifteenth century, are to be preserved. The stones are to be carefully removed and numbered. The foundations will then be strengthened, and the stones reassembled in their former positions. The work of restoration is to be carried out by Sir John Arrol, the well-known bridge builder, to whom the work is intrusted.

THE STATUE OF THE SUMERIAN KING DAVID.

BY EDGAR JAMES BANKS, FIELD DIRECTOR OF THE BABYLONIAN EXPEDITION OF THE UNIVERSITY OF CHICAGO.

The white marble statue of the Sumerian King David was discovered by the expedition of the University of Chicago while excavating at the corner of the ancient temple hill at the ruin known as Bismya, in Central Babylonia. Despite the discoveries of the fine old crematorium, the first that has come to light, and of the use of the arch in Babylonia as early as 4000 B. C., the finding of this ancient work of almost prehistoric art is one of the most interesting results of the expedition. When found it was lying upon its back, its head was missing, and the toes, which were broken from the feet at the time of its fall from the platform above, were lying just beneath it. The head was later recovered from another part of the ruin. In places, especially upon its face, is an incrustation of saltpeter, common to objects which have long been buried in the soil of Babylonia; other parts of the statue are as perfect as when it left the hands of its sculptor.

The statue is 88 centimeters high and 81 in the circumference of its skirt. The head is bald, the face beardless, the triangular eye sockets, to which ivory eyeballs were once fitted and held in place by means of bitumen, are now hollow. The shoulders are broad and square, the body thick and short, the well-shaped arms are free from the body, and the hands, according to the usual Babylonian custom, are clasped in front. The upper half of the statue is nude, and from the waist is suspended an embroidered or plaited skirt intended to represent heavy wool or fur. To give support to the statue, the bare feet are imbedded in the pedestal. Upon the right shoulder, the clearly cut inscription of three lines in the old Sumerian or pre-Babylonian language, reads as follows:

(The Temple) Eshar,
King Daudu (Daud = David),
King (of) Udnunki.

The name of the king is entirely new to Assyriologists. The names of the city and temple were first read upon the great stone of Hammurabi, recently discovered by the French in Persia.

The age of the statue is beyond doubt several centuries more than six thousand years; the approximate date of 4500 B. C. is fixed in several different ways.

First, the archaic character of the writing is that employed only in the inscriptions long antedating the early Babylonian king, Sargon, of 3800 B. C. The characters of the inscription are lineal and nearly hieroglyphic; the wedge-shaped characters were not yet developed.

Second, the statue when found was lying beneath the platforms of several reconstructed temples. The uppermost of the platforms contained bricks inscribed with the name of Dungi, of 2750 B. C.; beneath it was a platform constructed of the bricks of Sargon, 3800 B. C.; still lower were traces of several other reconstructions. The statue was beneath all of these, among the ruins of a temple built of small plano-convex bricks which all Assyriologists assign to the middle of the fifth millennium B. C.

Third, the style of the art, the triangular-shaped eyes, the nose forming a straight line with the forehead, the style of dress employed only at that particular period, identify it as belonging to the same age as the famous bas-relief in the Louvre and a statuette in the British Museum. The great Assyriologists of Europe assign the figures possessing these peculiar characteristics to about 4500 B. C., and no Assyriologist of repute, and who is acquainted with the earliest Babylonian art, would question the date.

The statue, fully 1,500 years earlier than any other from Babylonia, not only presents history with the name of a forgotten king; it is a perfect specimen of the most ancient art in the world, and opens a new chapter in the history of the earliest known people of Mesopotamia.

THE STATUE OF THE SUMERIAN KING DAVID, FOUND AT BISMYA, BABYLONIA, AND BELIEVED TO DATE BACK TO 4500 B. C.

A HAND-PRESSURE RIVETING MACHINE.

BY DR. ALFRED GRADENWITZ.

As a consequence of the unceasing development in the field of metallic constructions, which are being applied now to the most varied uses, the necessity of hydraulic, pneumatic, or electric riveting tools is becoming more and more urgent. In spite of the widespread use of these mechanical outfits, many rivets have still to be driven by hand-operated hammers. Such work is, however, rather hard, and especially in small shops are there seldom workmen of sufficient skill to be found. On the other hand, hammer-riveting has the inconvenience that the walls to be joined are not pressed together with sufficient force. The same drawback, by the way, applies to pneumatic riveting hammers, which, moreover, use up large amounts of compressed air. It may finally be stated that many delicate constructions undergo an unfavorable influence from the shocks produced by the hammer strokes.

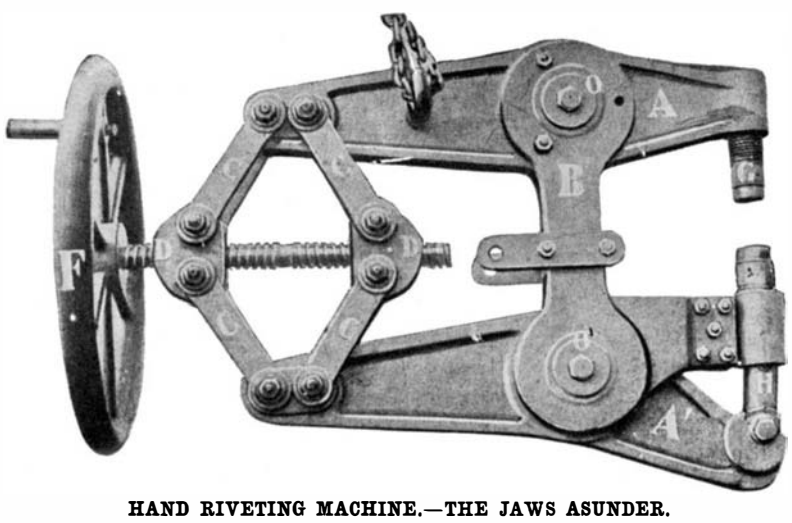
The tool represented in the accompanying figures has recently been constructed by Mr. F. Arnodin with a view to obtain by hand labor, and without the aid of any mechanical force or any hammer, rivets as satisfactory as those obtained by hydraulic pressure or other mechanical means.

This hand-driven riveting machine consists mainly of two cast steel arms, *A A′*, carrying at one of their ends and in front of each other the two stamps between which the compression of the rivet is to be obtained. The upper arm, *A*, being fitted with the counter-stamp, *G*, that is regulated by a screw, is bolted in *O* to two cast-steel cheeks, constituting a cross beam between this arm and the joint, *O′*, of the other arm, *A′*. The stamp is connected to the latter by a holder, *H*, and slides in a guide rigidly connected to the cheek so as to be kept in an invariable direction with regard to the counter-stamp. The levers, *A* and *A′*, are controlled by eight connecting-rods, *C*, made of steel, and which are coupled together by pairs and jointed on one hand to these levers, and on the other to bronze nuts, *D*, fitted with opposite threads. The screw, *E*, corresponding to this nut has likewise opposite threads and is controlled by a cast-iron fly-wheel, *F*, fitted with a handle.

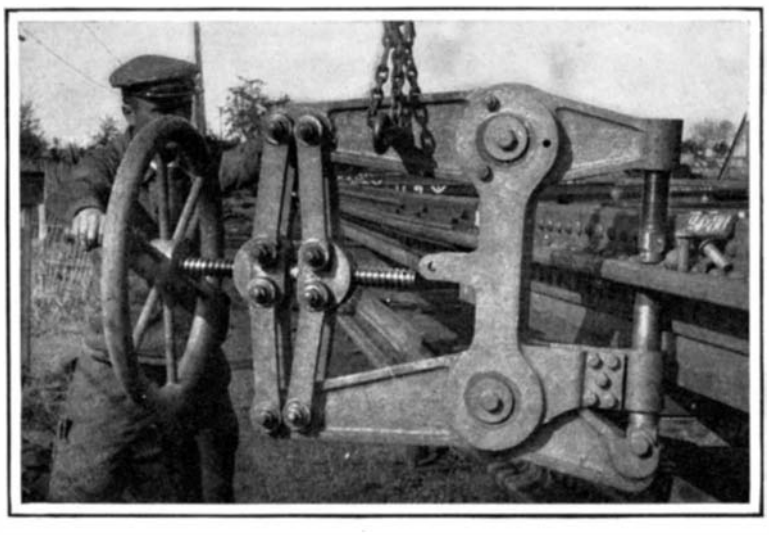
One of the two men required to operate the machine places the rivet in position, applying to it the counter-stamp, *G*, whereas the other operator sets the fly-wheel rotating rapidly. The lever, *A′*, swinging round an immovable joint will transmit to the stamp an increasing force, which in the case of a riveting machine of 365 kilogrammes weight, may reach as much as 30,000 kilogrammes, owing to the storing of energy secured by the fly-wheel, which is sufficient to deal with rivets 26 millimeters in diameter.

The apparatus is conveniently suspended from a tackle by two rings screwed to the lever, *A*. A rivet of 26 millimeters diameter is as a rule completed in two minutes.

The apparatus is dismounted and remounted at a moment's notice, any connections being obtained merely by means of bolts and nuts. In some cases, and particularly in smaller shops, it will be found advantageous to install the machine permanently at some point of the shop, especially in the case of light work.



HAND RIVETING MACHINE.—THE JAWS ASUNDER.



HAND RIVETING MACHINE.—JAWS BROUGHT TOGETHER.

Dissimulated State of Acids.

M. Albert Colson recently made some experiments which seem to prove that certain acids are capable of remaining in compounds in a state in which they appear to be different from the usual condition. The solution of a metallic oxide in a dilute acid gives, as we know, a dissolved salt. This should keep the characteristic properties of such a salt. He finds, however, that the solution of chromic oxide in cold dilute sulphuric acid gives a variety of sulphate in which the sulphuric acid resists the action of reagents, while up to the present we obtain analogous bodies only by modifying ordinary salts by heat. Hydrated chromic oxide is formed by adding ammonia to chrome alum. The precipitate is green. It is dissolved in a small quantity of very dilute sulphuric acid and filtered from the excess of hydrate. The green solution has the formula $Cr_4(SO_4)_5(OH)_2$. It seems to be a constant body. In this case the sulphuric acid should be all precipitated by barium chloride. But only three sulphuric molecules are brought down, while the other two remain, so that the mixture only clears with great slowness and even then contains the elements of sulphate of barium. This is confirmed by thermo-chemical research. One molecule of $Ba\,Cl_2$ added to one of the pentasulphate gives off heat represented by 5,000 calories. This number rises to 15,200 calories with 3 $Ba\,Cl_2$, giving a deposit of 3 molecules of $Ba\,SO_4$, but it does not exceed 15,500 with 4 $Ba\,Cl_2$. The fourth molecule of barium thus has no appreciable action on the chromium salt. Thus we find that the combination of sulphuric acid and chromium hydrate gives rise to two different states—the ordinary saline state and the "dissimulated" state. The latter tends to disappear when the temperature is raised. Cooling below the usual temperature also modifies it. We cannot therefore say that it is due to the formation of a special salt.

It is probably difficult for the young men in our technical schools of to-day who are familiar almost entirely with mild steel and very little with wrought iron, to realize what a change came in engineering when the production of mild steel became a commercially reliable matter. When we look back at the way in which some of the vital elements of a big marine engine were made, we are almost inclined to wonder that the material was reliable at all. The difference between a large wrought iron shaft such as old Hughey Dougherty used to make at the Morgan Iron Works, and one of the mild steel shafts made at Bethlehem, is as great as could be imagined. Nearly the same is true of boiler plates. The young engineer of to-day would hardly know what was meant by a lamination or a "cold shut." The very method of manufacture made it necessary to use a large factor of safety in designing, with the result that the working stresses permissible were very low and the weight of machinery inordinately high. With the advent of mild steel and the introduction of careful and systematic testing, the designer had a material on which he could place absolute reliance so that the factor of safety could be greatly reduced. As a matter of fact the factor of safety has been reduced from 8 or 10 to 5, and sometimes as low as 4.5.

AERIAL TRAMWAYS IN THE TUG RIVER COAL FIELDS.

BY HENRY MACE PAYNE, C.E., PH.D., SC.D.

It is within the past three years that the use of the aerial tramway has been introduced for the purpose of carrying coal in the West Virginia and Kentucky coal fields.

In both cases, illustrated herewith, it is used to carry the coal mined on the Kentucky side of Tug River, to to the railroad on the West Virginia side. The plant at Vulcan, W. Va., was first put in, and was the first adaptation of the idea to a coal-carrying process by the Leschen people. The second plant of this kind was built for the Borderland mines at Nolan, W. Va., and is similar in every respect.

The upper terminal at Vulcan is about 400 feet in elevation above the lower terminal, and the horizontal distance from saddle cap to saddle cap is a little over 1,100 feet. The empty cable is 1½ inch, the loaded one 1⅞ inch. The loaded bucket is suspended from the upper cable by a pair of trolley wheels, and is moved by the automatic attachment of the clip on the lower, or moving, cable. The trolley wheels in entering and leaving either terminal pass directly from the steel track to the standing cable at the saddle cap. The moving cable, which derives all its motion from the loaded buckets going down, passes through the terminals on sheaves, and around the ends on the large horizontal wheel. The periphery of this wheel consists of a patented anti-slip grip, through which the cable passes.

At regular intervals a clip is attached to the moving cable, whose purpose is to pick up the loaded or empty bucket at each terminal after it has been left there by the preceding clip. To regulate the strain on this clip and the moving cable, and to avoid any sudden jerking of the bucket, which would cause it to swing unduly, the A. Leschen & Sons Rope Company, of St. Louis, who manufactured the machinery for these plants, have designed an accelerating and retarding mechanism. As the bucket comes into either terminal, the pin on the clip slides between two rods and is raised, thus releasing the bucket, which stops at the proper point as it loses its own momentum. At the same instant a traveling piece is set in motion, which starts the stationary bucket out from the terminal so that when the clip has overtaken it the increase in speed is so gradual that no shock is transmitted to any part of the machinery.

Three independent bands are provided as brakes, all acting on separate circumferences attached to the axle of the large horizontal wheel, or drum, at the extremities of the moving cable line. The levers which work these brakes are all within easy reach of the operator at the upper terminal, by whose side is a telephone connecting with the other terminal. This same operator also raises and lowers the slide at the bottom of the chute into which chute the coal is emptied from the mine cars on the tramway above, and from which the buckets are loaded.

The capacity of the buckets is 18 cubic feet (about 900 pounds), and there are 23 buckets on the entire line, which makes a complete revolution at average speed, in about ten minutes. The maximum capacity, therefore, as now equipped, is slightly over 60 tons per hour and it is generally operated so as to carry about 45 tons per hour.

To provide for the changes in the length of the standing cable, due to tension, temperature, etc., the lower end passes over a large sheave and holds suspended a weight box whose load approximates 20,000 pounds. The large horizontal wheel carrying the moving cable, at the lower terminal, is supported by a sliding carriage, to relieve any tension on the terminal machinery or cables in case of sudden stoppage. To hold the moving cable at proper tension, this sliding carriage is counterbalanced by a weight box loaded approximately to 10,000 pounds, the weight of the carriage itself being about 5,000 pounds.

The loaded bucket upon coming into the lower terminal is automatically released in the same manner as at the upper, by the retarding and accelerating mechanism, and as the preceding empty bucket passes around the end of the terminal on its return trip, it raises an engaging lever which empties the loaded bucket just coming in. In this manner the entire process may be operated by one man, at the upper terminal.

The coal, after being emptied from the bucket, passes through the tipple in the usual manner, so that by the various screens, and the three tracks, it is possible to load lump, nut, or run-of-mine.

According to dispatches from Christiania, the Ziegler Arctic expedition, under the command of Anthony Fiala, of Brooklyn, has been successfully rescued by the relief expedition under command of William S. Champ, private secretary of the late William Ziegler. The Fiala party was found in Franz Josef Land, their ship, the "America," having been lost in the ice in Teplitz Bay early in the winter of 1903-1904. The members of the expedition lived mainly on cached stores left by the Abruzzi and André relief expeditions and their rescue appears to have been most timely. Three attempts to reach high latitude failed, though the intended scientific work was carried out successfully.

Iron Crystals and Curious Figures.

In a series of recent researches, M. Osmond, the eminent metallurgist, finds that very curious figures are formed on the surface of crystallized metals by pressing upon them with a fine point. A crystal of the metal is well polished and the point of an ordinary needle is brought down upon it. The needle is best mounted in a jointed lever. It is carefully placed against the surface of the crystal and perpendicular to it, then weights are put on the lever to press down the point. The surface is examined by the microscope in a vertical light. The figures which are formed around the point consist of groups of lines which in the case of iron are curved, but for other plastic metals of the cubic system are usually straight. The phenomena seem to be observed only with the plastic metals. He makes most of the researches upon iron, using large crystals which can be cut in different planes. The figures vary according to the plane of the section. The figures in some cases have the form of a cross with the point as a center, and are formed of streaks superposed. This happens upon the full face of the cube. In the sections the cross is imperfect, and in some cases there are three branches, in others two or only one. The figures are characteristic of the position of the sectional surface with reference to the crystalline structure, like the corrosion figures. Thus they can be made the base of a new method of research which will help in the following work: To differentiate two different bodies which have the same form of crystals. To find the crystallographic direction of an unknown section. This may have a practical value, as the fragility of iron and soft steel is connected with the position of the cleavage of the cube, and Stead's researches show that rolling of the plates may have an influence on the crystallographic position of the grains, in some conditions which are obscure at present. We also obtain a gage of the drawing of a metal, as the figures are smaller on drawn metal than on annealed metal. It is also found that a mechanical pressure or other action on a metal tends to change the character of the figures. At the breaking strain the figures almost disappear, showing that the crystalline structure is destroyed.

High-Tension 1,200-Volt Electric Railway from Grenoble to Chapareillan.

The electric railway which is now in operation from Grenoble to Chapareillan, twenty-six miles in length, is distinguished by the fact that it uses the three-wire direct-current system at a high voltage. This is one of the first electric lines in Europe where this method has been applied on a large scale. Up to the present the highest tension which has been employed for direct current tramways and electric roads is from 550 to 650 volts. This limit of tension makes it necessary to use wires of large section for conducting the current. In the lighting and power distribution lines we have the three-wire system which allows of increasing the tension and cutting down the expense of the lines. But for traction purposes, especially on long-distance lines, no application had been made of the three-wire system before the Grenoble-Chapareillan line. The Thury system is used here. The tension between the outside wires is 1,200 volts, and the middle wire is grounded by connecting to the rails. The track is of meter gage. Motor cars and trailers make up the trains, the cars having been supplied by the Ivry shops, near Paris, and the Schneider Company of Creusot, while the Thury electric equipment is used. The cars are of the ordinary tramway type and carry a motor on each axle. The motors are of the Thury four-pole 35-horse-power pattern and are coupled in series. A tension of 1,200 volts is used directly upon the motors. Controllers and resistances are placed on the roof of the cars and the driver works them by a hand wheel. The trains are usually made up of three cars and are supplied with magnetic brakes. Electric heating as well as lighting is used. At last accounts the road was in very successful operation, and this latest of M. Thury's exploits is attracting attention. There are about ten trains of thirty tons each now on the line. Current is obtained from a 1,400-foot fall at Lancey, some ten miles from Grenoble, where the hydraulic plant contains Brenier-Negret turbines and Thury dynamos.

The Current Supplement.

The current SUPPLEMENT, No. 1546, opens with an interesting illustrated article entitled "Experiments with the Langley Aerodrome," written by Prof. Langley, of Smithsonian Institution. "The Scientific Lantern" is by the late G. M. Hopkins, and is fully illustrated. "The Motor Cycle Race for International Cup" is by the Paris correspondent of the SCIENTIFIC AMERICAN, and is profusely illustrated with interesting engravings. "Electric Power from Blast Furnaces" is a timely article upon an important subject. Dr. Henry Draper's very valuable paper on "The Construction of a Silver Glass Telescope Fifteen and a Half Inches in Aperture, and Its Use in Celestial Photography" is concluded. There are the usual Science Notes, Engineering Notes, and Trade Notes and Recipes.

Electrical Notes.

The British Admiralty propose offering facilities to Mr. A. T. Johnson for testing his selective system of wireless telegraphy upon a practical working basis at sea. The characteristic feature of this invention is that when a message is dispatched to a certain point it is impossible for it to be received by any other than the requisite station, neither can it be intercepted or dispersed during transmission. In this device the inventor utilizes in his transmission apparatus the ordinary Ruhmkorff coil. On the base of this, however, is attached a reed disk. Armatures provided with weighted heads are fitted to this disk, and carry tuning reeds. The electric contact is made in the usual manner. The receiver comprises permanent magnets, strengthened with electro-magnets, and with an arrangement of steel reeds similar to those fixed to the transmitter, and with those on which they can be timed in unison. In transmitting a message the operation at the transmitter revolves the reed disk until the timing reed and its speaking reed are brought immediately in front of the center cone or cones of the electro-magnet. The contact pillar is then placed in connection with the speaking reed so that the vibrations thereof cause synchronous vibrations in the timing reed, which is the indicator. The vibration of this latter reed indicates to the transmitting operator that his companion at the receiver is getting the message satisfactorily, since the indicator must vibrate in unison by the law of syntonic synchronism. Experiments are being made in London with the system daily, and so far have proved successful. It would seem, however, that the great difficulty would be to obtain perfect unison in two stations situated at great distances from one another, owing to the liability of the reeds being affected by climatic and temperature conditions which are constantly varying.

The Grenoble Light and Power Company are now operating a system of current distribution throughout the region surrounding that city. The generating station, which is operated by hydraulic power, is situated at Avignonnet on the Drac River, a mountain stream which affords a large supply. The overhead lines are now furnishing current for the mines at La Mure, as well as for the towns of Voiron, St. Victor, Moirans, and others in the region. The farthest point lies at 100 miles from the hydraulic station. This distance is now to be increased as far as Annonay, and this will make the longest distance which has yet been reached in Europe for power distribution, as the total distance from Avignonnet to Annonay will give nearly 140 miles of overhead line. Another long-distance line is now in construction, and the same company is undertaking it. The line starts from the new hydraulic plant which lies at the Plombières Falls near Moutiers, and is to run to the city of Lyons at a distance of 112 miles. The current from the new plant is to be used for operating the tramway system of Lyons, which is very extensive, and is constantly increasing, both as to length and traffic. The present dynamo plant in the city is operated by steam engines, but this has now proved insufficient to meet the demands for current. The Compagnie de l'Industrie Electrique, of Geneva, is charged with the equipment of the station and lines for the new plant, which is to have four pairs of double dynamos in the Moutiers station and five corresponding sets of double motors, which will be placed in a station at Lyons. The latter station will receive the current from the overhead line and transform it into the proper current for operating the tramways. The new plant is unique in several ways. It will have one of the longest lines in Europe, as the distance of 112 miles has not yet been reached, and will be only exceeded by the Grenoble system mentioned above, when the latter is completed. One remarkable point about the Lyons system is that it is to carry out the distribution of current on the high voltage direct-current system, known as the Thury system, which attracted so much attention in the St. Maurice-Lausanne plant in Switzerland. In the present case we have 6,500 horse-power coming from a 200-foot fall. The Thury system was selected as having the greatest advantage in the present case owing to the economy in the line, which was but two small wires, and to the great distances which can be covered at a small cost. The voltage on the new line is to be higher than any which is yet employed, namely, 57,000 volts when the machines are running at their full load. With this high tension we are able to transmit 6,500 horse-power over 112 miles by using two copper wires of 9 millimeters. The line will follow the Isère valley for part of the way, and in general it passes through a mountainous region. Where it enters the city of Lyons the line is formed of two very highly insulated and armored cables, as the tension is still 50,000 volts.

Correspondence.

A Watch Puzzle.

To the Editor of the SCIENTIFIC AMERICAN:

An extensively advertised watch puzzle is being used to furnish publicity for a popular watch. The face of a watch is shown with the hour, minute, and second hands all on the same dial and so placed that the angle between any two of the hands is 120 deg. The question propounded is: "How soon will the hour, minute, and second hands again appear at equal distances apart? It looks easy. Can you do it?" It is not stated that the watch is of the split-second variety, hence the supposition that the second hand is directly connected to the train of gearing moving the other hands, and if this is the case the position of the hands shown is one in which it would be impossible for them to place themselves, unless the driving mechanism was somewhat irregular. If the watch is a split-second stop watch it can be so manipulated that at intervals of 21 9/11 minutes the three hands will either be at angles of 120 deg. or immediately superimposed.

In the illustration the position of the hand can be best defined by using the 60 one-minute spaces on the face of the watch as units. The hour hand has covered 14 6/11 spaces, the minute hand has covered 54 6/11 spaces and the second hand as shown has covered 34 6/11 spaces and is 1 9/11 spaces in advance of its proper position, if its movement occurs in the proper ratio with the movements of the hour and minute hands, its proper position being at 32 8/11 spaces if the movements of the hands occur in their normal ratio. If the second hand can be manipulated it would be possible to have the three hands an equal distance apart again after an interval of 43 7/11 minutes had elapsed, and their respective positions would then be as follows: The hour hand at 18 2/11 spaces, the minute hand at 38 2/11 spaces, and the second hand at 58 2/11 spaces; while if the second hand moved at its normal ratio with the other hands its position would be at 10 10/11 spaces.

Problems of this character which involve an infinite series of terms are solved by a very simple rule or formula.

The limit of an infinite descending geometrical series is $\frac{a}{1-r}$, in which a is the first term and r is the ratio.

For the watch problem a equals 1/3 of 60, or 20, and r equals 1/12 for the time in which the minute hand will gain 1/3 of a revolution, or 120 deg., over the hour hand, and this formula works out that the hour hand moves 1 9/11 minute spaces while the minute hand moves 21 9/11 minute spaces, and the second hand, if it moves in its proper ratio with the other hands, makes 60 revolutions while the minute hand makes one, and hence will in 21 9/11 revolutions, or, to state it another way, will make 21 revolutions and 49 1/11 minute spaces. By carrying out this computation it will be found that if the proper ratio of movement of the three hands is adhered to it will be impossible for them to ever arrive at a position in which they are equal distances apart. Of course it would be possible to set the second hand so that at twelve o'clock it did not agree with the other hands, and in this case once in twelve hours the hands would assume the position shown in the illustration, or by using a stop watch the second hand could be manipulated as before mentioned, or if the gearing of the hands was improperly proportioned such a position of the hands would be possible, but this last would mean an inaccurate watch. Assuming that the puzzle is based upon inaccurate ratio in the motion of the hands and that the second hand only was affected, this hand gains 1 9/11 seconds in 2 hours 54 6/11 minutes; that is, its ratio of movement to that of the minute hand, instead of being 60 will be $60\frac{1\ 9/11}{174\ 6/11}$.

A. D. WILLIAMS.

Highwood Park, Weehawken, N. J.

Can the Baalbec Stone Be Moved?

To the Editor of the SCIENTIFIC AMERICAN:

Referring to the inquiry made by Mr. Edwin Sidney Williams, of Saratoga, Cal., in your issue of June 24, asking the question, "Can the Baalbec Stone be Moved?" personally, I believe that modern mechanics could bring the huge stone, now about half way out of its quarry, to America. But Americans don't do things without a purpose, and it seems to me that it would be difficult to find a purpose which would justify the undertaking. The estimated weight of the stone is about 1,500 tons; it is about 80 feet long, and about 16 feet square at the ends. The road from Baalbec to Beirut is down grade all the way, but there are some exceedingly sharp turns in zig-zag. In many places the traveler has to go four miles by road to attain one mile.

Baalbec is 3,840 feet above the sea level, and from a scientific viewpoint is one of the most interesting places in the world. Its massiveness almost overwhelms one's imagination. If all the ruins of ancient and modern Rome were gathered together in one group, they would not exceed the ruins of Baalbec. The material used in the construction is mostly limestone, very richly decorated, although there is a part of a circular temple supported on six granite columns. It has been proved without a doubt that this granite was brought from the vicinity of Karnac in upper Egypt, down the Nile, across the Mediterranean to Beirut, thence to Baalbec by the zig-zag road. This is the only entrance to the city from the sea. It would be no larger an undertaking for us to bring the Baalbec Stone to our shores than it was for the ancients to bring these Cyclopean columns from Karnac to Baalbec.

From carvings found upon monuments and walls, it is inferred that the ancient Greeks and Romans handled these huge stones by animal power only. If electricity or steam had formed any part of their mechanical knowledge it is reasonable to infer that some record of it would now be found in the numerous pictures graven upon their stones. But such is not the case. The legacy they have left us shows that they utilized the inclined plane and pulleys. One of the largest stones used in construction during the Baalbec building boom measures 64 feet in length, diameter and height being about 14 by 15. This stone lies at a height of about 25 feet above the present ground level, and it is quite generally conceded that these hewn rocks, about the same size as a Pullman palace car (to use Mr. Williams's simile) were put in position by building earthworks in the form of long inclined planes reaching to the elevation desired, the rock being pulled up the inclined plane on rollers by means of cables operated on pulleys, and drawn by animal power. Subsequently the earth-works were removed. It is noticeable that these pictures always show a vast number of men operating at one time.

The city has passed under the rule of Persians, Greeks, and Romans. It has been plundered by Arabs, sacked by Tartars, dismantled by Saracens, Persians, and modern tourists. It is quite probable that earthquakes and Christians have wrought more ruin here than all the other vandals. Baal (or Apollo, as we know him) was worshiped in the Temple of the Sun. The six Corinthian columns, like grim sentinels guarding the unequaled beauties of the Bekaa Valley, form one of the most imposing relics of the world.

Syracuse, N. Y. EDWARD H. DANN.

An English Golf-Ball Decision.

The decision was recently delivered in the Chancery Division of the British Law Courts in the action brought by the Haskell Golf Ball Company, of the United States, against an English firm for an injunction to restrain the latter from infringing the Haskell patents in the manufacture of golf balls. The feature of the Haskell ball is its composite nature, comprising a kernel, a core, and a cover. The core is of a highly elastic material, such as rubber thread wound under high tension, which gives the ball a remarkably high degree of elasticity coupled with high rigidity and resistance, while the cover itself is non-elastic, tough, hard, and light. The effect of this combination is that the ball has special driving qualities. The defendant firm had placed three types of balls upon the market similarly built. Hence the action. The defendant firm, however, pleaded want of novelty in the Haskell ball and anticipation of the patent. The case was decided on the point of novelty. The defendants produced evidence to show that winding rubber-thread balls were made and sold twenty-five to thirty-five years ago, whereas the Haskell ball was not patented until 1898. Two other inventors had produced wound-rubber thread balls, but had not taken the trouble to patent their inventions, and although it was not shown which of these two inventions was produced first, the judge held that one of the two was the actual inventor, and therefore the Haskell ball was not novel. Judgment was therefore found against them, and their patent rendered invalid.

In the irrigated sections of this country, the landowners living along one stream are more or less dependent on each other for their respective supplies of water. One person disposed to appropriate more than his share can readily do so by diverting and holding the water, to the detriment of the farms situated farther down the stream. This is the cause of unending disputes, and all of the States in the West have laws designed to overcome it. A new and novel gate arrangement has been recently patented to meet this emergency by L. H. Rhead, a resident of Utah, stationed at the Rio Grande reclamation project, where he represents the United States government. This gate regulates the flow of water at the heads of distributing canals and laterals, and is especially designed where the scarcity and unsatisfactory distribution of water cause trouble among those concerned. The device consists of an iron gate stem, threaded, and two wheels also threaded to fit the stem. One of the wheels is for the purpose of raising and lowering the gate, and to the other wheel is attached a chain and padlock, by means of which the second and smaller wheel is locked in any position on the stem, and this constitutes the locking device. This is fixed at a point which will give a landowner all the water he is entitled to, and will permit him to cut the flow off entirely or partially if desirable, but he is unable to increase it to the point of depriving his neighbors of their share.

Engineering Notes.

A new smoke-prevention device for boiler furnaces has been invented by Mr. J. S. Pearson, of Glasgow. The system consists of discharging a combination of steam, air, and producer gas into the furnace. The three elements are combined and discharged onto the fuel in the front of the furnace through nozzles fitted to short pipe connections. The resulting chemical action releases the hydrogen in the steam, and combines the oxygen with the carbon in the fuel. The decomposition of the supplied gases is thus completed, and, by combining with the fuel gases and the resulting new gases thus produced, creates great heating power, emitting heavy smoke. The latter, however, decreases in volume toward the tubes, in which there are only flames, and is completely consumed before it reaches the chimney. The steam pressure does not vary with the stoking or cleaning of the furnace, and no ashes or clinkers are formed. The system can be applied to any type of boiler.

Utilization of Combustible for Freight Trains in Germany.—The Organ für die Fortschritte des Eisenbahnwesens reviews the modifications desirable in the methods of traction for freight trains in Germany. The reduction in the loads since 1895 has increased the expense about 28 per cent. The average number of axles per train has, during the same period, been reduced from 70 to 67. The expense of personnel has increased. It is true but irrational that while the loads have been diminished, the power of the locomotives has been increased. The construction of heavy freight engines capable of considerable effort is regarded as an error. It is more advantageous to draw ordinary trains by engines of average power, utilizing the steam under the best conditions, and if necessary overdriving temporarily, when the amount of freight becomes abnormal, than to employ locomotives which in the majority of cases are too powerful. The economic remedy in the diminution of loads consists in the increase of speed, particularly on inclined grades, where the weight should be turned to profit. But for security the number of brakes should be multiplied, where there is not a continuous brake for the train, as in England.

Preparation of Railway Cross-ties.—The Revue Générale des Chemins de Fer describes the preparation of cross-ties by the Compagnie de l'Ouest by means of the injection of creosote. Works for the purpose are established at Surdon in the department of Orme, about the geographical center of the railway system. The yard occupies more than eight hectares. The ties, on arrival at the yard, are classified according to their comparative resistance to the penetration of creosote, and are piled up so as to dry by means of a free circulation of air. This requires from six months to a year, after which they are placed in hot-air driers for twenty-four hours and afterward in large hermetically sealed injection cylinders, heated by steam worms, under a pressure of two kilogrammes, which allows of maintaining a uniform temperature of 80 deg. C. for the creosote. A vacuum is produced in the cylinders, which are put in communication with the creosote vats. When filled with the liquid, an inside pressure of seven kilogrammes is caused by means of pumps for thirty-five or forty-five minutes. The annual production at Surdon is 297,000 cross-ties, and 200,000 posts, stakes, and other pieces.

The earliest recorded attempt at superheating was that reported in 1828 by Richard Trevithick, at the Birnie Downs Mine in Cornwall, on a condensing pumping engine making eight strokes per minute, with a boiler pressure of 45 pounds, in which the cylinders and steam pipes were surrounded with brickwork and heated from a fire burning on a grate underneath. The results were remarkable, for, while performing the same amount of work, 9,000 pounds of coal were used per twenty-four hours without the fire under the cylinder, against 6,000 pounds when it was in use, the coal for superheating included. This experience led Trevithick to the invention of his tubular boiler and superheater, which was patented in 1832, and was a remarkably modern-looking arrangement, the boiler proper consisting of vertical water tubes surrounding a circular grate and forming a vertical flue in which other tubes were placed, through which the steam, generated in the boiler, passed on its way to the engine. Owing, no doubt, to the difficulty in regulating the temperature of the steam obtained from such an apparatus, little seems to have been done in the matter during the next ten or fifteen years, although in 1832 I. Howard, of Bermondsey, produced a superheater which obtained an economy of 30 per cent, and about 1835 Dr. Haycroft, of Greenwich, advocated superheated steam and found experimentally, about the same saving.

MEASURING THE MECHANICAL EQUIVALENT OF HEAT.

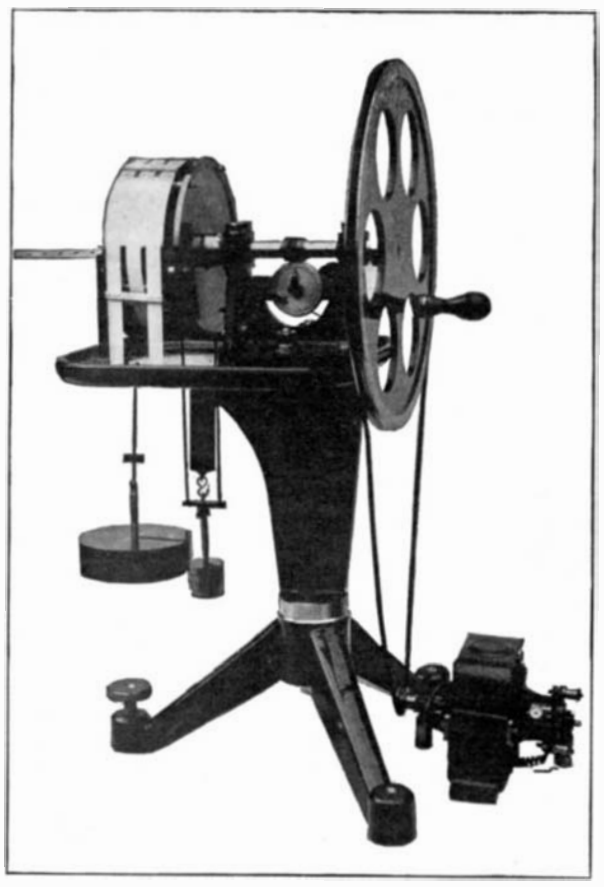
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A new apparatus for measuring the mechanical equivalent of heat was recently described before the Physical Society of Great Britain. It is the invention of Prof. H. L. Callendar, F.R.S., who devised the Callendar electrical thermometers, and is manufactured by the Cambridge Instrument Company, of Cambridge, England. The apparatus comprises a cylindrical calorimeter of thin brass, the axis of which is horizontal, and which contains a previously determined quantity of water. This calorimeter is rotated at a moderate speed either by hand or by means of a water or electric motor. From the ends of a silk belt slung over the cylinder unequal weights are suspended and arranged so as to make one and a half complete turns round the cylinder. A light spring balance is attached in order to insure stability of equilibrium and this acts in direct opposition to the lighter weight. As this spring balance contributes only a small (positive) term to the effective difference of load at the two ends of the belt the small errors in its readings which focus are relatively unimportant. The extreme flexibility of the belt insures that to a very high degree of approximation the difference of load at two ends is the true measure of the friction. The weights are adjusted by trial to suit approximately the friction of the belt, the final adjustment being effected automatically by the spring balance. A counter registers the number of turns which have been given to the calorimeter, while the rise of temperature is read by means of a bent mercurial or platinum thermometer, inserted through a central opening in the front end of the cylinder. The external loss of heat is either eliminated by Rumford's compensation method, or by carrying out two experiments with different loads on the belt. The motion of the surface of the calorimeter eliminates the effect of drafts and convection currents, so that the loss of heat is much more regular than if the surface were at rest.

The stand of the apparatus may be screwed to the table or to a wooden board with heavy weights upon it. The silk belt is wrapped round the calorimeter so as to encircle it one and a half times; three-quarters of the circumference of the calorimeter is then overlaid by the single part of the belt and a like amount by the double part of the belt. The single part of the belt is at the same side as the spring balance and thereto is attached the stem for carrying the lighter weights. By means of a leveling screw the axis of rotation of the calorimeter can be rendered approximately horizontal. When the apparatus is utilized for lecturing purposes, the calorimeter may be driven by means of a ¼-inch round leather belt from a small water or electric motor. In order to obtain success in operation the revolving velocity of the calorimeter should be from 60 to 120 turns per minute. With 4 kilogrammes on the double side of the silk belt, the rise of temperature approximates 1 deg. C. per 100 revolutions. The simplest method in which to carry out an experiment is to deliver about 350 grammes of water at 10 deg. C. from the pipette into the calorimeter by means of the small rubber tube and brass nozzle which fits into a screw hole near the rim. The motor is then set in motion at a suitable speed and readings of the temperature taken every 100 revolutions. It is necessary to observe the mean temperature of the surrounding air near the calorimeter during the experiment, then select from the observations a range of 500 or 600 revolutions during which the mean temperature of the calorimeter is nearly the same as that of the air. The correction for external radiation will then be practically negligible.

After starting the calorimeter the weight on the spring balance side should be adjusted so that the 4-kilogramme weight is raised clear of the stops and held in floating equilibrium with the reading of the spring balance somewhere near the middle of its scale.

After 100 or 200 revolutions the friction will become practically constant. The silk belt must be kept clean or the friction will not be steady. The work is the product of the difference of the weights on the two sides, the heavy weight plus the spring balance reading minus the light weight by the number of revolutions and the circumference of the calorimeter, which is measured with a thin steel tape. The heat generated is the product of the total thermal capacity of the calorimeter, and its contents by the observed rise of temperature. The latter must be corrected for errors of the thermometer, and reduced to the scale of the air thermometer.



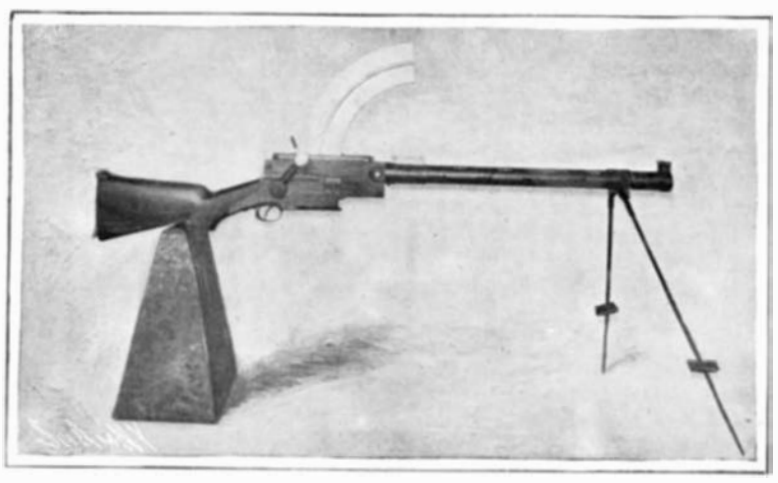
PROF. CALLENDAR'S APPARATUS FOR MEASURING THE MECHANICAL EQUIVALENT OF HEAT.

The apparatus is very simple both in its design and appliance and is of special value for demonstration and lecturing purposes. It is reliable in its operation because the friction is almost independent of the speed. The balance is automatic. Furthermore there is no change in thermal capacity of the calorimeter with change of speed or of load. No errors can occur, as there is no pulley or bearing friction. Lastly the factors of the mechanical work expended are ascertainable to a high degree of accuracy.

THE REXER AUTOMATIC MACHINE-GUN.

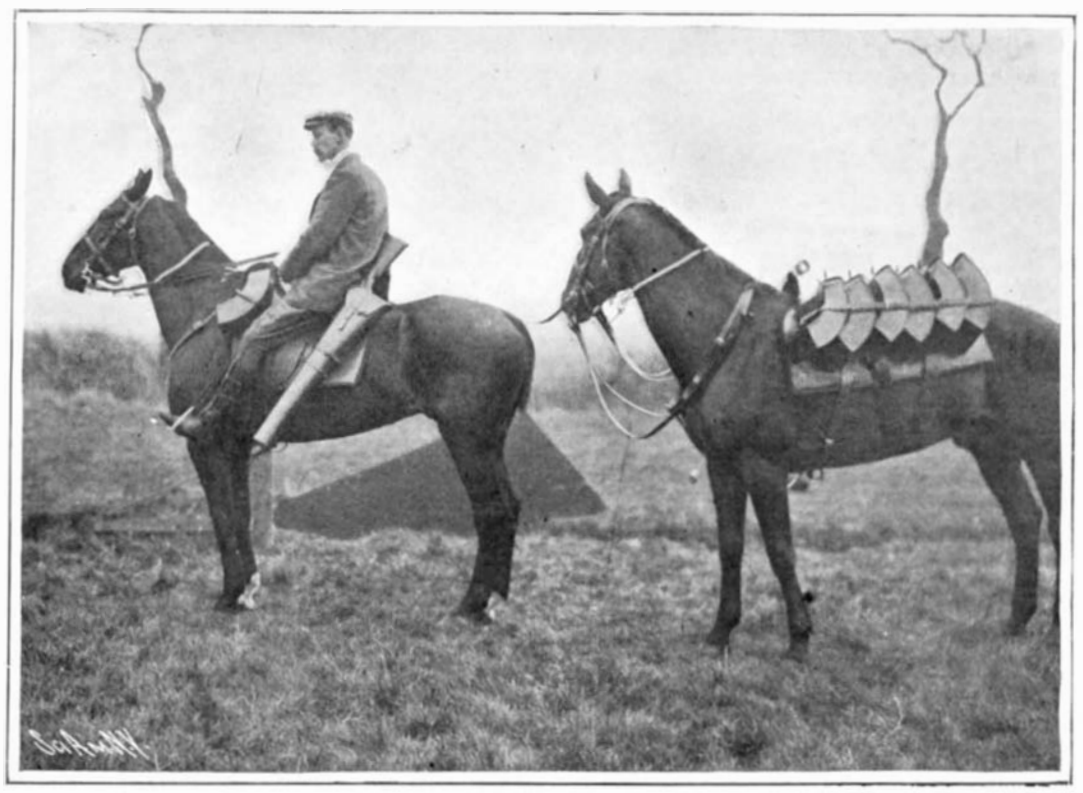
For a number of years we have been accustomed to consider that our modern rapid-fire and machine-guns were capable of little improvement, and that the weapons of this branch of naval and military artillery would remain practically unchanged for some time. As regards the rapidity of fire this belief appears to be correct, for there are certain physical reasons, such as the heating of the gun barrel, which tend to keep the rate of discharge within certain limits. But great advances have recently been made in the simplification of the mechanism and the reduction of weight of machine-guns in a Danish invention, now known to the public as the Rexer automatic machine-gun. It is claimed for this weapon that the fighting power of all branches of the army service will be greatly increased by reason of its lightness and portability, combined with its comparatively high rate of fire, while at the same time the transport requirements will be reduced. The gun has been adopted by the Danish government, and a number of others, including Japan, have reported favorably upon its performances.

The Rexer machine-gun is really a shoulder-arm, and resembles a large rifle of the ordinary type. Its weight is about 17½ pounds, and while this is considerable in comparison with that of the common rifle, it is a vast decrease from the 60 pounds of other machine-guns. The operation of the weapon is very simple. The gunner lies flat on the ground with the stock pressed against his right shoulder. Two light legs, forming a support, are attached near the muzzle end of the outer casing and the special joints with which these are provided permit the weapon to be trained into any position and to be elevated or depressed within generous limits. When not in use the supports are folded back against the barrel. The cartridges, contained in curved clips or magazines in batches of twenty-five, are fed into the top of the breech casing by the left hand of the gunner. A single pull of the trigger, and the twenty-five cartridges in one clip are discharged in less than two seconds. A rate of 300 shots a minute can be maintained with little trouble, and as the supporting legs and a perforated casing surrounding the barrel proper obviate any handling of the same, the gunner is not troubled with the heating of the weapon. The position of the operator—flat on the ground—affords the greatest protection with minimum "cover;" and this, together with the inability of an enemy to distinguish the Rexer gun, even at short distances, from an ordinary rifle, gives this type of weapon a preponderating advantage over many other kinds of rapid-fire guns.



HOW THE REXER RIFLE IS FIRED.

HOW THE REXER RIFLE IS CARRIED.



THE REXER RIFLE AND ITS FIELD EQUIPMENT OF AMMUNITION.

Fundamentally the Rexer gun depends upon the same basic device as nearly all other weapons of this type, as the power for working the mechanism is obtained from the recoil. The weapon comprises essentially the stock, the casing, and the trigger-plate, which inclose the breech mechanism, the

rifled barrel, and a perforated barrel-casing or outer tube. The recoil drives the barrel with the breech and other moving parts some two inches backward within this outer tube, thus compressing a strong recoil spring which is inclosed within the front part of the stock. This, after the force of the recoil is spent, expands and drives the barrel forward again into the firing position, the recoil and return of the breech operating a mechanism within the casing which ejects the empty cartridge-case, inserts a new cartridge into the chamber, closes the breech, and fires the shot.

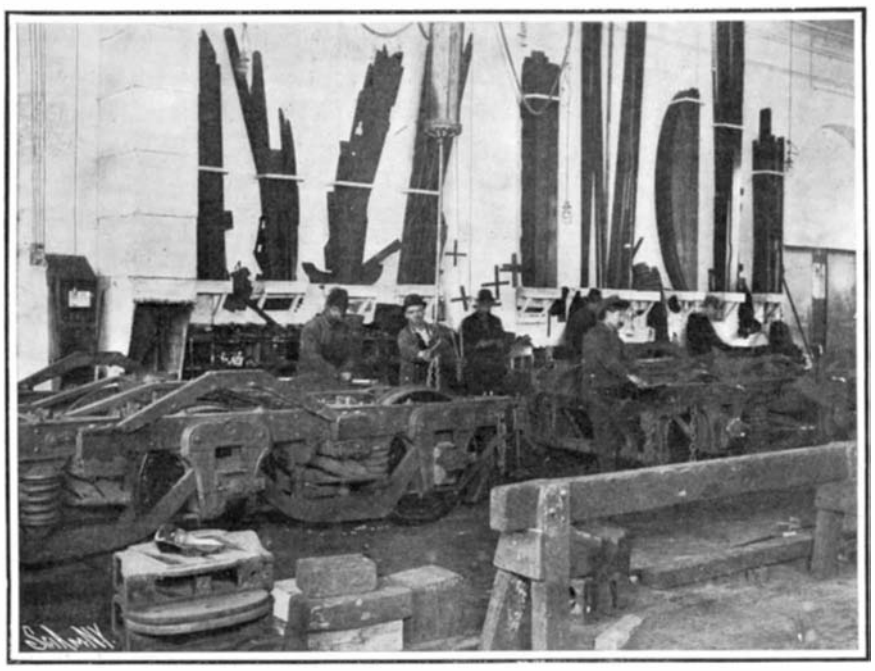
Among other advantages claimed for the Rexer machine-gun is its convertibility by a simple process into a single-shot rifle, by which it becomes available for deliberate shot-by-shot fire like an ordinary rifle or carbine. For the reasons given above, it is less liable to be put out of action than any other machine-gun, for its inconspicuous appearance will not attract undue or embarrassing attention from the enemy. By reason of its lightness and portability, it is easily carried on the march by cavalry or infantry. This fact is demonstrated by the illustrations, which show as well the ingenuity and practical simplicity of the equipment.

THE BUILDING OF A RAILWAY CAR.

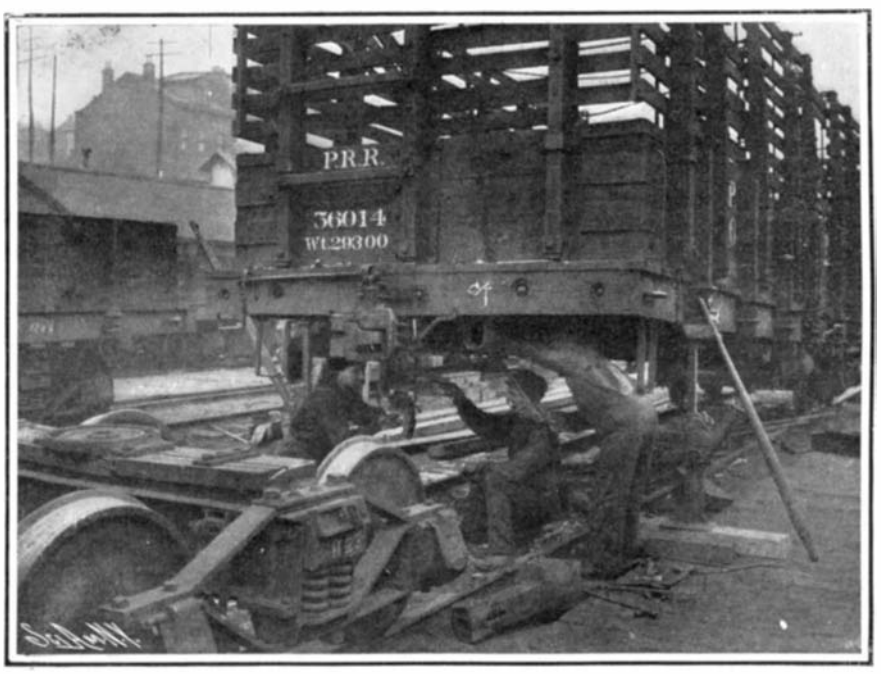
BY DAY ALLEN WILLEY.

The passenger car as seen on the standard-gage American railroads of to-day represents the progress of over a half century which has been made in the construction of this type of rolling stock. Experts have given the United States credit for building not only the strongest but most comfortable and convenient passenger coaches in the world. Whether this tribute is deserved or not, there is no question that the so-called day coaches in service on the principal systems are much more substantially constructed and more luxuriously appointed than even ten years ago. In fact, some of them are nearly equal to the ordinary Pullman car in upholstery, decoration, and conveniences.

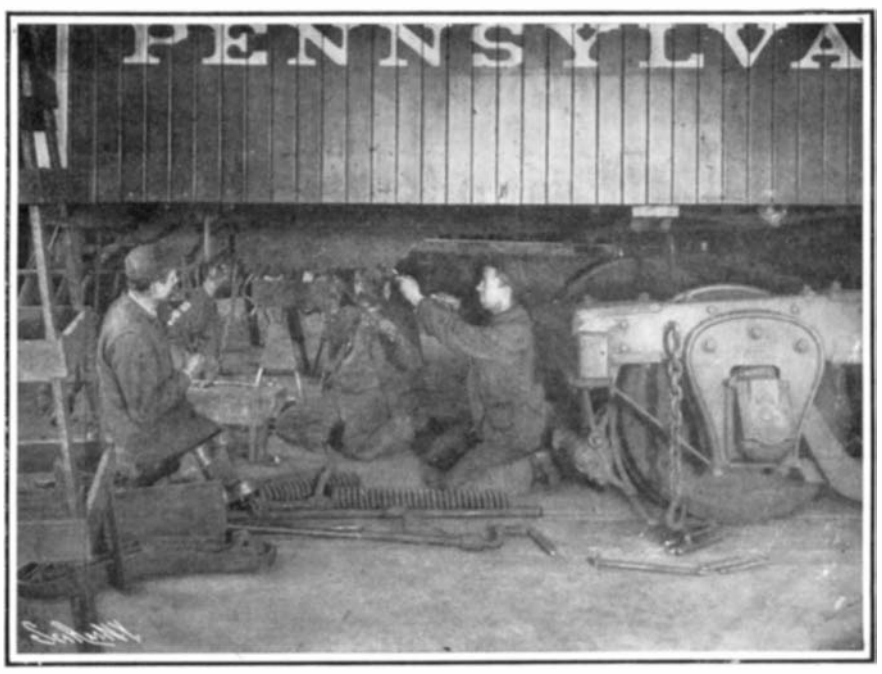
It has been the aim of the builders, especially in recent years, to design a car of a sufficiently strong framework to prevent telescoping in collisions and other forms of accident, since the driving of one car through another has been one of the principal causes of great loss of life. The coaches of to-day can withstand far greater impact than even a few years ago, but this is not strange when the plan of building them is studied. In most instances the car builder commences at the bottom and works upward. First, he lays down what might be called the backbone upon supports usually placed, for convenience, high enough to allow the trucks to be run under the car when completed. The backbone is generally composed of Georgia pine timbers extending the entire length of the body and 5 or 6 by 8



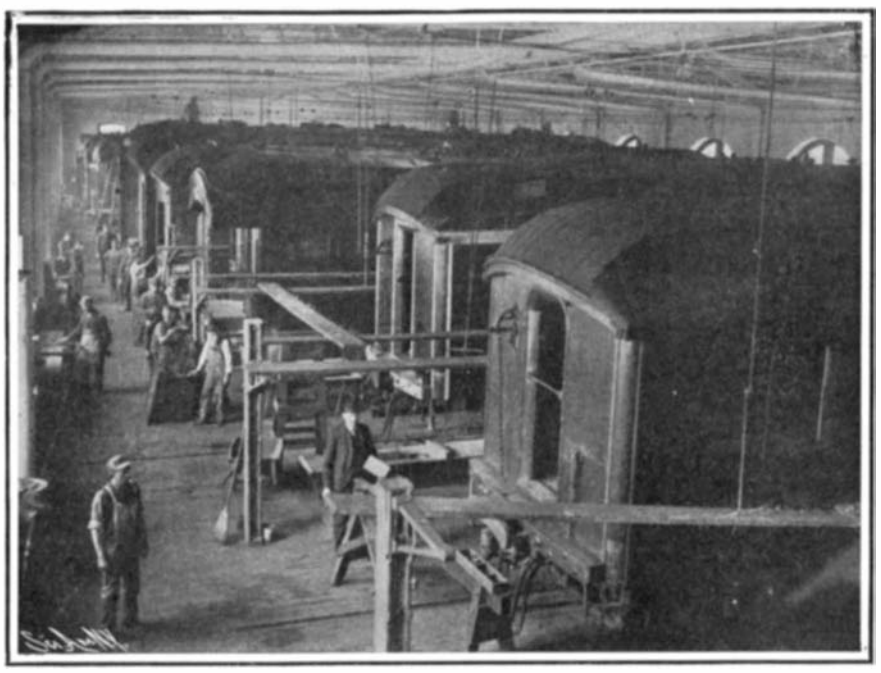
Assembling Car Trucks.



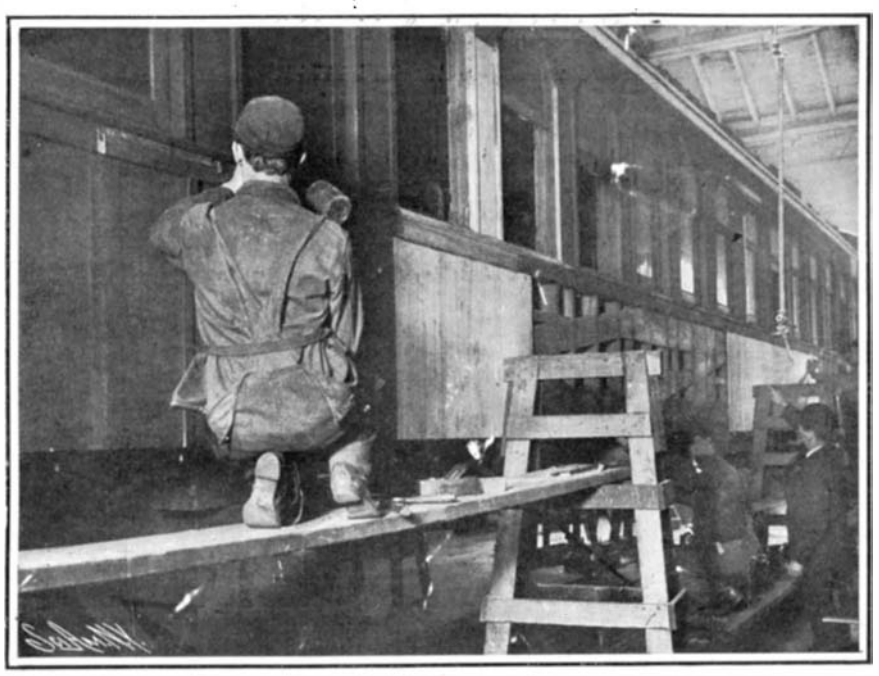
Fitting a Truck to a Freight Car.



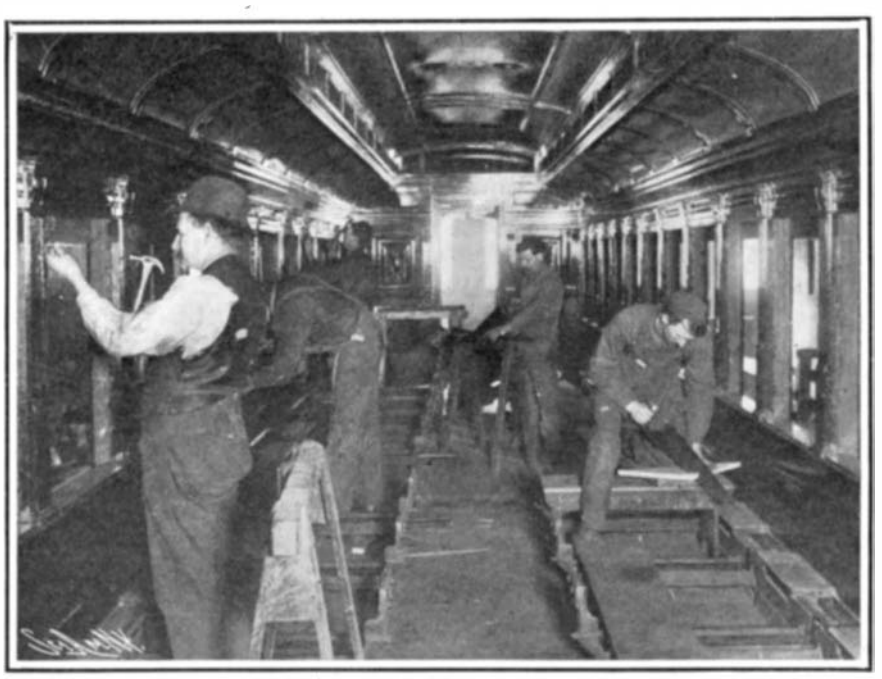
Fitting a Truck to a Completed Car Body.



In the Paint Shop.



Putting the Siding on a Skeleton Car Body and Hanging the Piping.



Nailing on the Hardwood Finishing.

THE BUILDING OF A RAILWAY CAR.

inches in thickness. As the average car body ranges from 50 to 70 feet in length, it is difficult to secure any other kind of wood in such sizes free from defect. The timbers are reinforced on their inner surface with steel plates totalling about an inch in thickness and of the width and length of the timber; this gives about as great strength as if the beams were of hardwood. These sills, as they are termed, form the outside of the backbone and are connected by transverse beams of the same wood placed at frequent intervals and fastened to the sills with steel bolts. To give additional strength, however, bolsters are attached to the under side of the beams forming supports for the car when it rests upon the truck. In the center of each bolster, which is made of heavy casting, is a steel pin about 1 foot in length and 2 inches in diameter, which fits into an opening in the top of the truck and connects the two portions.

In addition to the framework referred to, truss rods ranging from 1 to 1½ inches in diameter extend the full length of the car, passing through the end sills. Under the center of the framework is placed a partition of timbers, under which the rods are stretched. This forms a sort of bridge, and allows the rods to be tightened at the ends by the use of nuts and washers. Four are placed under each car and serve to distribute the weight more equally, preventing any bending at the center; the trusses are further reinforced by short rods extending across the car bottom at regular intervals.

With the foundation completed, the work of building the sides begins by setting the upright posts. Those at each corner are of steel, and they are so connected at the top that the end of the car is really a steel arch. At the sides oak or ash posts are used, and they are so reinforced and bolted together that a strain on any part is shared to a great extent by the entire skeleton of the car. Every joint is fastened with a bolt and a nut and practically no nails or spikes are used. This is true to a large extent of every part of the car, glue taking their places in the lighter work. As soon as the main uprights are in place, they are topped with heavy sills extending the length and breadth of the car and adding still further to the strength. The roof skeleton is built with the same degree of solidity.

The first operation in the interior work consists in laying the floors. The modern passenger coach has no less than three, which are required not only for strength, but also to inclose the steam and other indispensable pipes. The first floor, which is laid directly over the framework, is merely intended to cover it, and is composed of yellow pine planking fastened directly across the car body. Upon this are placed the pipes for steam, compressed air, water, and gas (if the latter is used for illumination). When the plumbers and gas fitters have completed their work the second floor is laid down to inclose the piping, but the strips are much narrower than those comprising the lower floor, and are laid diagonally from side to side, in order to give strength. Upon them is laid the top floor, the planking also being placed diagonally, but in such a manner as to cross that below it in the form of a letter X. It is partly due to this fact that passenger cars offer so much resistance in collisions. The invention of the vestibule, however, has been another safeguard in this respect, especially in the prevention of telescoping, while, as is well known, it is one of the greatest conveniences which have yet been invented to add to the comfort of the traveler. If a car is to be vestibuled, this addition is fastened to the platform while the interior work is in progress.

When the flooring is completed and the skeleton of the car body is fastened together, the work can be carried on very rapidly, for while the carpenters are inclosing the sides and putting on the roof, the machinists can be working underneath fitting the body with the air and other tanks, as well as the brake machinery. The siding of the ordinary day coach consists of two layers, of which one is usually poplar grooved and tongued and thoroughly seasoned so that it will fit tightly. With the siding put in place the door and window frames are set and the cornices placed in position. The roof skeleton is covered first with light wood, on which is fastened either tin or canvas.

With the completion of the roof the exterior of the car is ready for painting, and this is usually finished before the interior work is ended. Car builders believe in plenty of paint and varnish, and from ten to twelve coats are applied to the outside. As the first three or four coats are applied, each is thoroughly rubbed down with water and powdered pumice stone and another added. Recently compressed-air painting machines have been employed at some of the larger shops, the liquid being forced through nozzles and applied to the surface in jets, and this method has taken the place of the brush; but the finishing coats of varnish must be applied by hand, while the lettering, of course, is all done by specialists in this class of work.

As soon as the sides and roof are on the car, work on the interior begins. The finishing woods are attached directly to the skeleton timbers. Quartered oak, mahogany, yellow poplar, and cherry are frequently used in one car. They are coated heavily with varnish to protect them from the action of dust and cinders. Following this the lavatory cabinets are erected, and the heat registers, chandeliers, ventilators, windows, shades, and seats are placed in position. This completes the car with the exception of the tests and perhaps a few finishing touches.

As already stated, the car body is usually mounted on a platform so that the trucks can be run under it and attached in a very short space of time. While it is under construction the truck makers are busy in the machine shop connecting the springs with the truck frames and attaching the latter to the axles and wheels. The trucks are so nearly completed when ready to be put under the car body that but very little work with the wrench and hammer is needed to make the coach ready for service. While a large number of the ordinary passenger coaches are equipped with four-wheeled trucks, recently the tendency has been to increase the number of wheels to six, following the example of the Pullman car builders. The advantage of the six-wheeled truck is to distribute the weight of the car body over a larger area and gives it more even motion when under way; but one objection to the six-wheel truck is that it is far more expensive in proportion than the four-wheeler. The wheels principally used at present are composed of cast centers fitted with steel tires. Entire castings of wheels are no longer favored and the era of the paper car wheel has also about passed away for use on standard-gage railroads.

It is interesting to note that in constructing modern freight cars where wood forms the framework and outside, the method followed is very similar to that in passenger coach building. First the backbone or bottom frame is built of reinforced timbers of sufficient size to bear the load which the car is intended to carry when full. Upon the framework is erected the wooden skeleton, but usually only a double floor is laid instead of three, as the freight car carries so little mechanical equipment compared with the passenger coach. Of course, there is no interior finish, with the exception of a few coats of paint, but the sides and roof of the modern box car are built about as strongly as if they were intended to carry passengers. The majority are equipped not only with air brakes but hand brakes as well, as a double precaution in case of accident.

The cost of building passenger coaches has increased rather than diminished with the progress which has been made in their design owing to the additional work which is required, also the many valuable woods which are utilized in their decoration and finish, as well as the upholstering. The standard day coaches in service on the larger systems of the United States seldom cost less than $6,000 and may range as high as $7,500. They are heavy vehicles, weighing from 35 to 40 tons when ready for service. The majority can seat sixty passengers, but nearly forty more can be crowded into the remaining space if necessary. One of the principal expenses attending the construction of these cars is the steam heating, lighting, and sanitary equipment. These features alone represent an outlay of from $1,200 to $1,500.

AN APPARATUS FOR MEASURING THE EARTH'S SPEED OF ROTATION.

BY OUR BERLIN CORRESPONDENT.

The classical pendulum experiment made by Foucault has borne out the fact that the law of inertia is satisfied for a space devoid of rotation with respect to the fixed-star sky.

Since this experiment is impaired by errors which render it possible to attain approximate results only, even if the utmost care be taken, it seemed desirable to make further experiments. It is true that Foucault himself endeavored to check his results with an experiment on a gyroscopic device, but on account of their inaccuracy these tests failed to aid him. Prof. A. Föppl, while engaged in a theoretical investigation of the gyroscopic device designed by Mr. O. Schlick for diminishing the rolling movement of a ship, described in these columns, employed a similar improved apparatus for carrying out experiments in which Foucault could not attain precision.

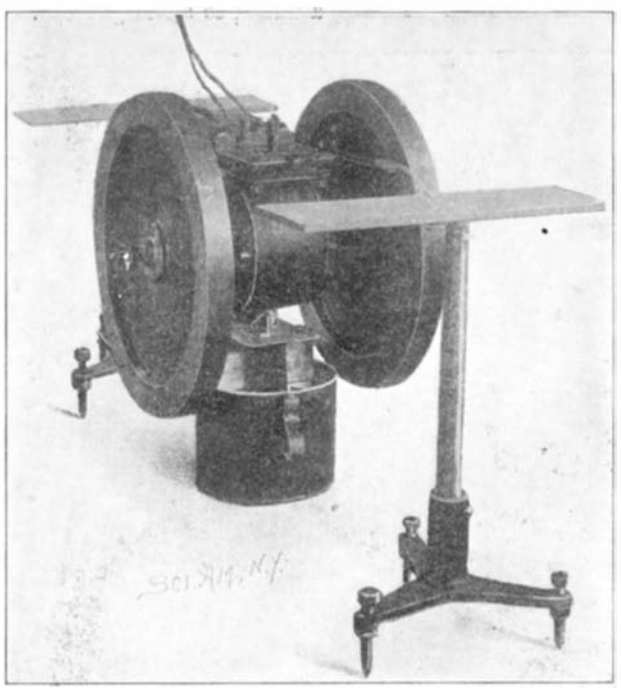


Fig. 1.

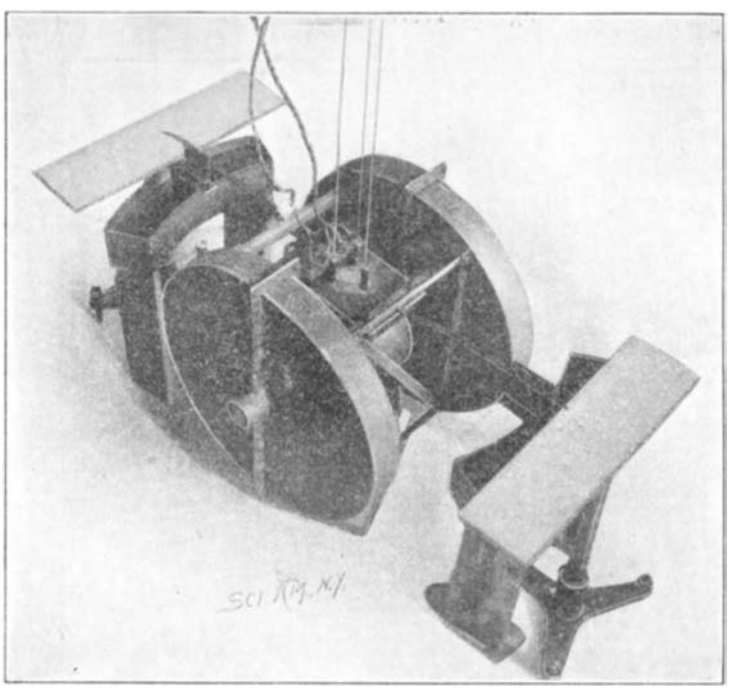


Fig. 2.

AN APPARATUS FOR MEASURING THE SPEED OF ROTATION OF THE EARTH.

As is well known, the deflection of the axis of a rotating top renders it possible to determine the speed of rotation of the earth, and any departure observed between the figure thus found and the astronomical earth rotation would contradict the results of the Foucault experiment. Moreover, there was the possibility of discovering a special influence of the rotation of the earth in the course of a gyroscopic experiment.

The apparatus designed by Prof. Föppl, as shown in the accompanying photographs, is a top consisting of two cast-iron flywheels, 50 centimeters in external diameter, each about 30 kilogrammes in weight and riveted to the other. These flywheels are mounted on the two ends of the shaft of an electric motor, having a speed of about 2,400 revolutions per minute. The motor is suspended by three steel wires from the ceiling of the room. The whole system can therefore rotate only about a vertical axis, and must overcome the resistance offered by the trifilar suspension. The motor is fitted with two crossed plates, dipping into an oil vessel placed below and serving to check the oscillations. On the top of the motor two indicators playing over scales may be seen.

In order to determine the speed of the top at any given moment, the wires leading to the armature are loosened from the external conductors and short-circuited by inserting the voltmeter, whereupon the electromotor will run for a short time as a dynamo and the angular speed of the armature can be figured from the voltmeter reading.

Experiments were carried out as follows:

The motor was started, speeded up to the desired point, and kept at constant speed for a quarter of an hour to half an hour. Since the top at the beginning of this period still had a certain precession velocity due to starting, it would oscillate very slowly (once in about 3 or 4 minutes) around the dead center. In order to ascertain that there had been no outside disturbance, the deflection of the indicator was read on

both sides every minute, the mean value being plotted as ordinates with respect to an axis of abscissæ representing time. From this curve the position of equilibrium about which the oscillation occurs was ascertained.

The air current due to the rapidly rotating fly-wheel at first produced some disturbance of the oscillation phenomena. This was overcome by surrounding the rotating parts with a casing (see Fig 2). The top then began to perform quite regular precession oscillations, no departures between the astronomical earth rotation and that inferred from these terrestrial motion phenomena being noted. The minimum speed available for these experiments was found to be 1,500 revolutions per minute.

The theory of the experiment, as given by Prof. Föppl, in the Physikalische Zeitschrift (No. 14, page 419, etc., 1904), is simple enough, if the precession oscillation be at first left out of account. Let the moment of inertia of the rotating masses be denoted by θ, their constant regular speed by w, and the angular speed of the rotation of the earth (supposing that this agrees with the astronomical earth rotation) with u. Let further φ be the geographical latitude of the place of observation, ψ the angle formed by the equilibrium position of the rotating top with the east-west direction, and M the moment of the couple transmitted from the suspension to the top frame in a horizontal plane. M should be equivalent to the vertical component of the speed of variation of the impulse of the top due to the rotation of the earth. The speed of variation of the impulse of the top will be equal to the product of the impulse itself and the angular speed of the rotation of the earth, being considered as a vector. The following equation is obtained:

$$M = \theta\, w\, u \cos\varphi \cos\psi.$$

The moment of inertia is found by calculation to be $\theta = 26.7$ cm. kg. sec^2; the geographical latitude was 48 deg. 8 min. 20 sec., and M practically proportional to the torsion of the suspended system with respect to the zero position when the top was at rest, thus equivalent to $c\ \chi$, χ being the angle of torsion, and c being 2.12 cm. kg.

The observations of the deflection of the top due to the rotation of the earth were relative only to the two cases when the zero position of the top at rest is either in the meridian or at right angles to it. In the first case there should be no deflection of the top's axis due to the rotation, provided the astronomical earth rotation also governs terrestrial motion phenomena. This was indeed brought out by the experiment.

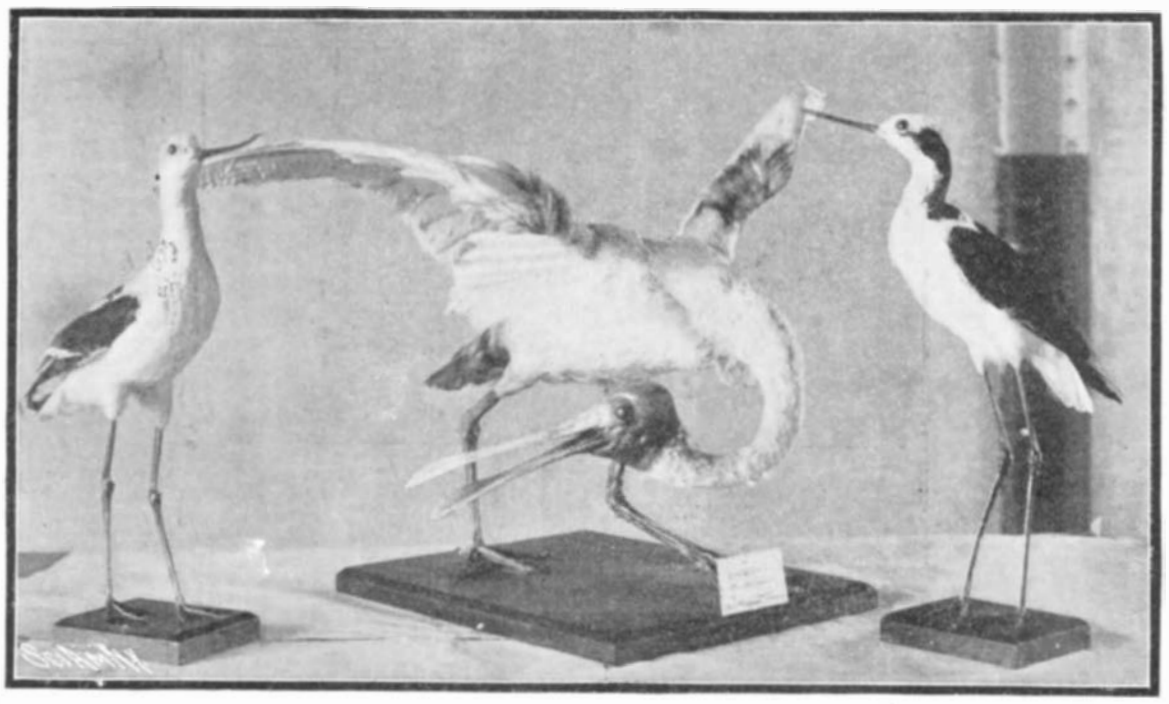
When the top's axis at rest is perpendicular to the meridian, the angle of torsion χ to which the moment M is proportional will coincide with the above angle ψ, the equation to be tested assuming the form:

$$c\,\psi = \theta\, w\, u \cos\varphi \cos\psi.$$

As an agreement within 2 per cent was found to exist between the angular speed of the rotation of the earth as derived from these terrestrial motion phenomena and the astronomical earth rotation, it seems likely that this agreement is as perfect as can be hoped. The experimenter hopes, however, to improve his apparatus and to ascertain whether some indications of possible departures are due to errors of observation.

Two Interesting Specimens in the Bird Collection of the Academy of Natural Sciences. On Left, Saddle-Backed Stork; on Right, Flamingo.

A Rare Pelican.



In the Center, a Roseate Spoon-bill of Tropical America; to the Right, a Black-Necked Stilt, the Longest-Legged Bird in the World for Its Size; to the Left, the Abocet.

A UNIQUE COLLECTION OF RARE BIRDS.

A UNIQUE COLLECTION OF RARE BIRDS.

BY HARRY DILLON JONES.

The Academy of Sciences of Philadelphia has always prided itself on possessing the most complete collection of birds in the world. Of late years Washington and New York have been struggling for supremacy in the ornithological world, and the Quaker City scientists have been quietly adding to their collection, in order to maintain the proud position allotted to them as long ago as 1857, when Dr. P L. Sclater pronounced the collection of birds in the Academy of Sciences to be superior to that of any museum in Europe, and therefore the most perfect in existence. Prof. Witmer Stone, the famous authority on bird life, has about completed his work of cataloguing the collection in the possession of the Academy of Sciences, and about one-third of the specimens are now on exhibition in the museum of the institution. Two-thirds of the collection will remain in air-tight and light-tight cases, where they will be at the disposal of any scientist seeking to add to his knowledge of ornithological subjects. The reason these specimens will not be placed on public exhibition is that they are far too valuable to subject to the deteriorating influence of light and air. It has been found that about forty or fifty years is the duration of the life of specimens placed in cases for public exhibition. Those on exhibition therefore will be specimens of which there are duplicates or those that can be replaced without a great amount of trouble. The very rarest specimens will not be allowed to see the light of day unless the curator of the museum is asked to show them.

Among the rare specimens is one of the great auk, and one of the eggs of that famous bird. The eggs are even rarer than the birds, for according to Prof. Stone there are only two in America, and a valuation of $500 to $600 is placed on them by collectors. Another rare bird of which there is a specimen in the collection is the Labrador duck. This bird is even more difficult to find than the great auk, for there are not more than forty-two specimens, according to Prof. Stone, in the world. The Sandwich Islands have been hunted over for rare birds, and quite a number of specimens have been brought to the Academy of species that will soon be extinct because of the onslaughts on the forests of the islands and the consequent killing off of the birds of the district. One specimen in the possession of the Academy is absolutely unique, Prof. Stone being unable to give it any name, so extremely rare is the species. It is a bird very similar in appearance to the common American warbler, but has distinctive features that place it in a class by itself.

That exceedingly shy and scarce bird, the flamingo, is represented by some handsome specimens in the cases at the Academy. Once they were not particularly rare in America, but now there is practically only one flock of them, which is seen by venturesome explorers in the southern part of Florida. The specimens at the Academy were bagged in the Bahamas, where they are still living in sufficient numbers to be found without a long search. The few persons who have tracked these great birds to their haunts have found that they build big nests in uniform rows along the ground. While the female bird is sitting on the nest, the stately male mounts guard by her side. The sight is a remarkable one when an entire flock is seen in this pose.

Among the pelicans of the collection are some from Florida, where they are becoming daily more scarce because of the demand for their plumage for millinery purposes. So far have the birds decreased in numbers, that the United States government has taken a hand in the hunt, and has established a pelican island on the east coast of Florida, as a permanent reservation for the birds, where they can live free from fear of the hunter, and save themselves from extinction because of the greed of the feather collector. At one time the pelican, with his huge bag beneath the beak in which he stored fish for the young, was to be seen as far north as Sandy Hook. Now it is necessary to go to Florida to find him. But for the government's thoughtfulness in setting apart an island for his use, the pelican would probably soon be extinct.

A pheasant with the most wonderful wing development of any of the

species in the world is to be seen in the collection. It is known as the Argus pheasant of India, and is seen in one of the accompanying photographs with its magnificent plumage outspread. Like all other birds that nature has provided with fine feathers, this bird is being rapidly hunted to extinction.

In all there are about 48,000 birds in the collection, which has been gathered from all parts of the world by various expeditions sent out by the Academy since as far back as 1812, when the first birds were obtained. Half a century or so ago a great effort was made to place the collection ahead of anything of its kind in the world. Dr. Thomas B. Wilson, president of the Academy, authorized Dr. J. E. Gray, of the British Museum, to purchase specimens in hundred lots. It appeared best, however, to buy established collections that happened to be for sale from time to time, and the splendid collection of Victor Massena, Duc de Rivoli, was bought and transferred to this country. In this collection were 12,500 rare specimens. Smaller collections were bought from time to time, among them the Gould collection of Australian birds and the Boys Indian collection, the latter gathered by Capt. Boys of the British army during his several years' residence in India.

Additions to the collection were made by the Du Chaillu expeditions, sent out partly under the auspices of the Academy of Sciences, and the D'Oca collection from Mexico.

Anæsthesia Without Chloroform.

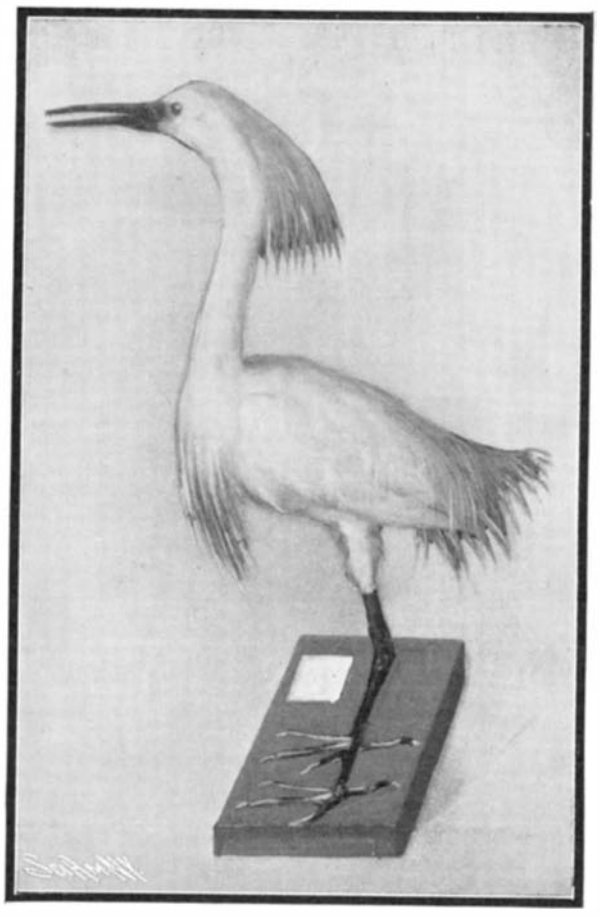
BY DR. ADOLPHE CARTAZ.

The French surgical society recently discussed the ever-important question of anæsthesia. What is the best means of administering chloroform, the usual anæsthetic, with the minimum danger to the patient and the maximum security for the surgeon? Now and then accidents occur despite the most elaborate care. The patient loses color, his breath fails, his heart ceases to beat, and life is gone. Though he has inhaled the vapor of only a few drops of the anæsthetic, he cannot be roused from sudden and fatal syncope. In order to prevent these accidents, as far as possible, several surgeons have conceived the idea of regulating the amount of chloroform inhaled by mixing it, in various definite proportions, with a known quantity of air. These are uncertain palliatives, and, as one of the surgeons remarked, the greater the elaboration of the apparatus employed, the greater is the danger of a lapse of attention of the assistant who administers the anæsthetic.

During this discussion the application of a new method was reported by MM. Terrier et Desjardins. Method is too strong a word; it is simply the employment of a vegetable alkaloid as an anæsthetic, instead of chloroform or any of the ethers. The idea of this substitution is due to Dr. Schneiderlin, of Baden. What led this surgeon to experiment with this substance? I do not know, for the power to produce general anæsthesia could not be inferred, *à priori*, from its known properties.

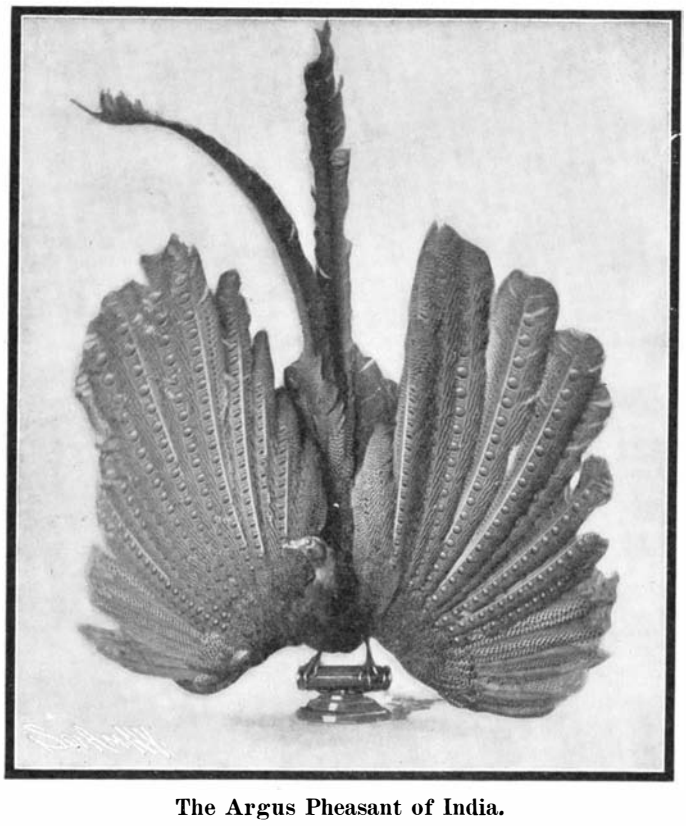
Scopolamine, the alkaloid recommended by Dr. Schneiderlin, was extracted by Schmidt, of Marburg, from the *Scopolia japonica*, a perennial herbaceous plant of the natural order *Solanaceæ*, popularly known as the Japanese belladonna. The first chemical analyses made by Langgaard, long ago, resulted in the isolation of an alkaloid, rotoine (from *roto*, the Japanese name of the plant), which exhibited all the properties of the alkaloids of belladonna. Scopolamine, indeed, exerts a mydriasic and a vaso-dilatory action (i. e., it dilates the pupils and the blood vessels) but it also possesses a narcotic power which inevitably produces a profound and dreamless sleep. Scopolamine has an inhibitory effect on the pneumogastric nerve, which is manifested by a retardation of respiration, an acceleration of the action of the heart, and a narcotic influence on the brain.

Schneiderlin and his school made use of this hypnotic property to produce anæsthesia. They employ a solution containing from a milligramme to a milligramme and a quarter of scopolamine to the cubic centimeter of water, with which they make a first hypodermic injection two hours, a second one hour, and a third one-half hour before the operation. To guard against accident, it is well to add to the solution, by way of antidote, a small quantity of hydrochlorate of morphine, say one centigramme to the cubic centimeter. Fifteen or twenty minutes after the first injection, the patient feels an irresistible desire to sleep. He combats it in vain, rubs his eyes, yawns, then succumbs, like a man exhausted by fatigue, and falls into a calm and natural sleep. After the second injection, his slumber becomes more profound, and his reflex irritability diminishes. If his name is called loudly he opens his eyes, but falls asleep again instantly. After the third injection, the sleep becomes so deep and anæsthesia so complete, that the surgeon is enabled to operate. It is a curious thing that, profound though the patient's slumber appears, it is not so deep that he cannot be roused, as from natural sleep, by a loud shout or noise. But he makes no response to pinching or pricking; his sensibility is gone, and anæsthesia is complete. Hence the operation must be conducted in silence, and the patient moved no more than is absolutely necessary, to avoid rousing him from his torpor. The most interesting feature of the new method, however, is that the anæsthesia persists so long after the operation, that the patient is spared the painful awakening and the suffering due to the wound and the dressing of it. He sleeps on for several hours after the operation is finished. Some patients awake after five or six hours, take nourishment, and fall asleep again for a longer or shorter time. On waking, they remember nothing of the operation or the events that immediately preceded or followed it. This is, surely, long-lived and effective anæsthesia.



The Egret—A Bird Whose Tail Plumage is Much in Demand.

This method, yet unknown in France, has been largely employed in Germany, where more than 1,500 operations have already been performed under its beneficent influence. Prof. Terrier and M. Desjardins have imported it. They have also modified it by combining the anæsthesia of scopolamine with that of chloroform. In some cases they make only a single injection of scopolamine one or two hours before the operation, at which they use a small quantity of chloroform. Whatever the modification employed, this method of producing anæsthesia offers valuable advantages, including the prolonged slumber, the persistence of insensibility on waking, and great freedom from danger, for as yet there is no record of a single fatality attributable to the anæsthetic agent. Cocaine allows us to dispense with chloroform in many operations, but it is available only as a local anæsthetic, while scopolamine puts the patient to sleep, and, according to the surgeons, who have used it, is less dangerous than chloroform. A great advance will be made, therefore, if this agent shall prove applicable to all surgical operations.—La Nature.



The Argus Pheasant of India.

A UNIQUE COLLECTION OF RARE BIRDS.

South-African Mining—Extent to Which Compressed Air is Used.

In speaking of South African mines in general, it is usual to refer to those in the Johannesburg gold district as typical of the entire country.

In the use of compressed air for mining purposes, the practice in the Witwatersrand represents the highest development of air power to be found in any one mining district. The variety and number of compressor plants in operation is probably unequaled elsewhere.

The diamond mines make little use of compressed air, since the diamond ground is comparatively soft and is drilled by hand jumpers; not even a hammer is needed in the Kimberley mines. The coal mines in Natal have very recently adopted compressed air for coal cutting, but particulars cannot be given here. The Rhodesian gold mines have followed the Johannesburg methods in this as well as other mining matters.

In the Johannesburg district the use of air drills was necessary from the first, as the hard "banket" gold ore cannot be economically developed by hand drilling alone. Owing to the low grade of the ore, the mines can only be successfully worked when large blocks of ground are developed. This condition led to the use of comparatively large compressors from the start, and the usual development through the small semi-portable, or straight-line, compressors did not take place, as is usual in a new mining district.

The early compressors were comparatively small and were extremely inefficient; they were usually of the duplex type, having slide valve steam cylinders, and plain poppet-valve air ends. The discovery of coal within 50 miles of the gold mine made the fuel problem an easy one to solve. It is a curious fact that it was more important to be economical of water than of fuel and for this reason even the earliest plants were run condensing. Coal was close at hand and could be bought, but if the limited water supply failed, operation became impossible. It is no fable that, even after Johannesburg had become a large and important town, water was so scarce that people used bottled soda water for their toilet as well as for diluting their "Scotch."

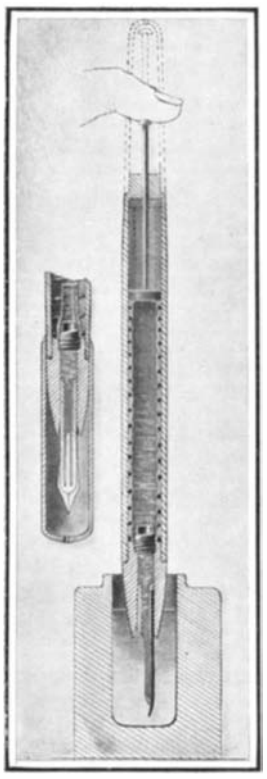
The present water supply is sufficient only for the existing mines; great additions are in development to provide for the increased demand which will arise in the near future. The result of this condition was the interesting development of the most economical type of compressors, not because of the fuel saving, but because the scarcity of water made condensing engines necessary and the coal economy followed. The present practice aims at both steam and coal economy, and compound condensing Corliss engines with two-stage air cylinders are the standard. The early boiler practice was not in keeping with the engine plants, and many semi-portable boilers were used to drive compound condensing engines. The later practice is to install the most economical boilers regardless of cost; many of them are of the "Lancashire" type so common in English and European plants, but almost unknown in this country.—Mines and Minerals.

When American engineers commenced to build iron bridges, they paid little attention to the then existing European models, but preferred to develop their own systems independently, as they had done previously with wooden bridges, the first iron bridges being imitations of the Towne lattice, and the Howe and Pratt trusses. All the earlier bridges were built principally of cast iron, wrought iron being used in tension members only. In the first iron viaduct built by the Baltimore & Ohio Railroad, in 1852, all parts were of cast iron, except the tie-rods. The wrought-iron tension members at that time usually consisted of round bars with screw ends, or elongated links made of square bars. Later, these links developed into forged eye-bars, introduced by J. H. Linville, M. Am. Soc. C. E., in 1861. These eye-bars have since become one of the distinctive features in American bridge construction. Although flat eye-bars were used in Europe at an earlier period, in chains of suspension bridges and in some types of trusses, they did not find favor there, and were soon discarded for structures with riveted connections.

Patent Department

AN IMPROVED FOUNTAIN PEN.

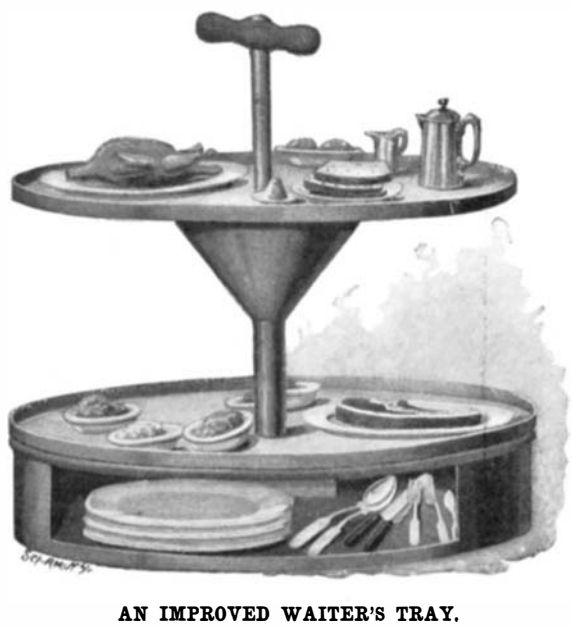
Pictured in the accompanying engraving is an improved fountain pen invented by Mr. Thomas P. Ambrose, of 638 Walnut Street, Cincinnati, Ohio. The improvement lies principally in the provision of means for quickly and efficiently filling the pen with ink. The pen comprises the usual barrel or casing into which the point section is threaded. The ink, however, is not contained directly in the barrel, but in a rubber tube or reservoir which fits into the casing. A water-tight connection is made between the rubber tube and the point section. Coiled around the tube is a spring which bears against a plunger at the upper end of the barrel. The stem of the plunger passes through a perforation at the end of the barrel, and terminates in a button, as shown. In operation the plunger is depressed, compressing the rubber tube. The pen point is then dipped into an ink-well and the button released. The plunger will be raised to the dotted position shown, by the coiled spring, and the rubber tube drawn up with the spring will be expanded. The ink will then flow up into the tube owing to the atmospheric pressure on the ink in the ink-well. When using the pen the ink will readily flow from the tube to the pen point, and in case of an obstruction it can be forced through the pen by the application of a slight pressure upon the button. While fountains with compressible reservoirs have been made before, this invention presents the advantage of providing for the more ready expansion of the reservoir to draw the ink into it and it also provides against the collapse of the reservoir to force ink from the pen faster than would be desired in writing. The plunger is separable from the spring and reservoir, and can be entirely removed from the casing, as is also true of the reservoir itself. The parts are thus readily accessible for cleaning.



AN IMPROVED FOUNTAIN PEN.

AN IMPROVED WAITER'S TRAY.

We have become so accustomed to the busy waiter darting through the crowded restaurant with his huge pile of dishes poised precariously over the heads of the diners, that we forget how crude a system of transportation this is. Even when a tray is used to carry the dishes the conditions are not much better, because the tray, to be properly handled, requires the use of both hands or else it is not even as safe as a pile of dishes carried directly on the arm. A recent invention, however, provides an improved tray which may be safely carried in one hand. Furthermore, the tray is formed with several shelves, so that a large number of dishes may be carried at a single load. The form of the improved tray is shown in the accompanying engraving. It will be observed that the main body of the tray consists of a drum. The circumferential wall is cut away at the forward side to permit of placing articles within the drum, and a transverse wall at the rear prevents the dishes from being shoved too far back into it. A rod rigidly attached to the upper wall of the drum is provided at the top with a transverse head-piece, forming a T-shaped handle. Resting on the beaded upper edge of the drum is a shelf consisting of a pan with a large central opening, to admit the rod, and a sleeve carried thereon. This sleeve is funnel-shaped and at the top it supports a second shelf. In use the waiter may bring in a large meal at a single load by placing the various dishes on the upper and lower shelves. Knives, forks, spoons, etc., may be carried in the drum. When the meal is finished, the plates could be placed within the drum and readily carried back to the kitchen. It will be observed that the center of gravity of the tray lies considerably below the handle, so that there will be no danger of upsetting the dishes. Mr. Ingram A. Merriman, of 117 North Main Street, Bluffton, Indiana, is the inventor of this improved waiter's tray.

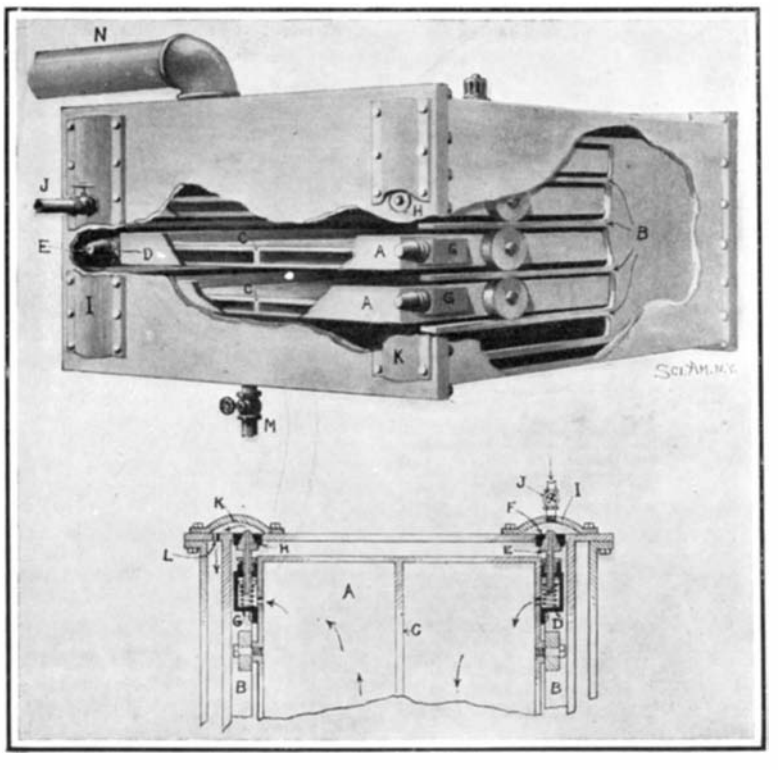


AN IMPROVED WAITER'S TRAY.

DRYING APPARATUS.

In the accompanying engraving we illustrate an improved drying apparatus recently invented by Mr. George Stiff, of 44 Lenox Avenue, Bridgeport, Conn. The apparatus is of the vacuum type and is so constructed that the material to be treated may be easily placed in it or removed therefrom. The drier comprises a double casing, between the spaced walls of which a steam chamber is formed. The inner casing, which is adapted to receive a number of pans or trays, *A*, is closed by a steam-tight door at the front. These trays are mounted on wheels which travel on tracks, *B*, formed on the inner walls of the inner casing. Each tray is provided with a double bottom, forming a chamber for the heating agent. This chamber is divided by a longitudinal, central partition, *C*, which, however, does not extend to the forward end of the tray, so that an opening is provided between the two chambers at the forward end. Communicating with the double bottom at the rear is a steam box, *D*, provided with an inlet tube, *E*, which has a cone-shaped head designed to engage a correspondingly-shaped inlet port, *F*, in the rear wall of the apparatus. The tube, *E*, is held yieldingly in its box by means of a coil spring. At the opposite side of the tray is an exhaust box, *G*, identical in construction with the steam box. The tube leading from this box is adapted to engage an exhaust port, *H*, in the rear wall of the casing. It will be evident that there is an inlet port for each tray, and these ports lead out from a common chamber, *I*, supplied with steam from a valve-controlled pipe, *J*. The exhaust ports also open into a common chamber, *K*, from which communication is had with the steam chamber through a number of perforations, *L*. In use the material to be treated is placed on the trays, which are then rolled into the inner chamber. The door is now closed against the trays, pushing them into place so that the cone-headed inlet and exhaust tubes are seated firmly against their respective ports, making complete steam connection. Then the steam is turned on and it circulates from each steam box through the double bottom of the tray, around the forward end of the central partition, *C*, to the exhaust box and thence the steam passes through the exhaust chamber, *K*, to the steam chamber. The water of condensation from the steam flows out through pipe, *M*. The vacuum in the apparatus is produced by a pump, which is connected with the inner chamber by a pipe, *N*. We are informed that the drying process is completed in much less time than is taken by many of the other types of vacuum driers and the temperature never exceeds 140 deg. F., thereby saving the destruction of material under operation, as is experienced, for instance, in drying tannic acid, dyewood extracts, rubber, and other substances.

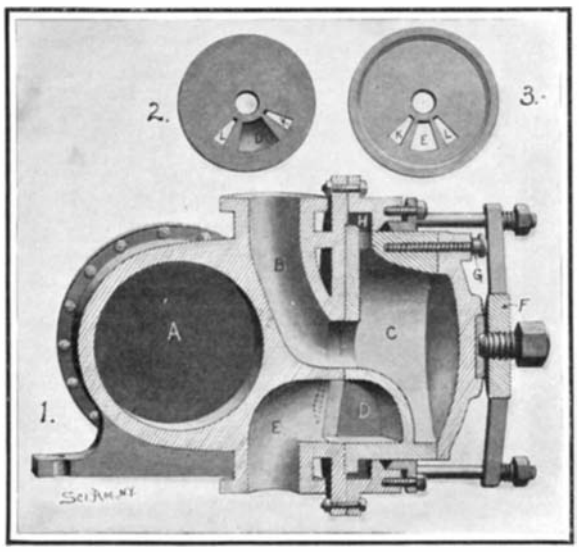
A new and interesting process which should prove of great value to decorative metal workers has been discovered by Mr. S. Cowper-Coles, of London. The method consists of fusing one metal into another in a temperature below the melting point of any of the metals used. By this means some novel effects can be produced similar in appearance to fine damascened work, or, in larger pieces, bold designs in vari-colored metals, such as zinc inlay on steel that has been blued to protect it against rust; or zinc on copper that by the metal fumes has been given the color of gold bronze. Any shades of color from silver-white to red copper may be obtained, according to the metals used, the preliminary treatment, and the varying length of stoving.



DRYING APPARATUS.

NEW ROTARY VALVE FOR STEAM ENGINES.

A new rotary valve for steam engines has recently been invented, which is designed to relieve the valve seat of boiler pressure, and to keep the balance of the valve without regard to the pressure in the boiler. The manner in which this result is obtained will be readily comprehended by reference to the accompanying engraving, which illustrates a section through a steam engine equipped with the improved valve. The cylinder is shown at *A*, and *B* is the port admitting steam from the boiler into the combined valve and steam chest, *C*. The bottom of the steam chest or valve, as illustrated in Fig. 2, is formed with a central opening communicating with the steam supply port, *B*, and is also provided with two radial openings, *K* and *L*, between which is a cut-away port, *D*. The valve seat, which is shown in Fig. 3, is similarly formed with radial ports, the port, *K*, communicating with one end of the cylinder, and port, *L*, with the other, while between them is the exhaust port, *E*. The bottom of the valve is formed with a flange which projects into an annular balancing chamber, *H*, formed by a cylindrical casing bolted to the valve seat. Communication between the interior of the valve and this chamber is had through the port shown. A steam-tight joint is made between this casing and the valve. The valve is mounted to rock in the casing and is held under pressure by a screw in the spring-pressed spider, *F*. The link which connects the valve with the rocker is shown at *G*. In operation the cut-away port, *D*, alternately connects the ports *K* and *L* with the exhaust port, *E*. The flange at the bottom of the valve extends into the balancing chamber to an extent sufficient to balance the excess of outward pressure due to the ports cut in the bottom of the valve, so that the valve is held down properly on its seat. It will be understood, of course, that the valve seat must be fitted to a ground joint in order to secure the desired action and that if the area of the flange be equal to the area of the ported openings a perfect balance will be secured at all times. Mr. John Cruikshank, of Yorktown, Pa., is the inventor of this improved rotary valve.



NEW ROTARY VALVE FOR STEAM ENGINES.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

RAILWAY-SIGNAL. — W. B. SMITH, Redlands, Cal. This invention refers particularly to improvements in signals placed on the cabin or rear car of a train, the object being to provide a signal of novel form and automatically actuated to show approximately the speed at which the train is moving, so that the engineer on a following train may see whether the preceding train is moving fast, medium, or slow and regulate the speed of the following train accordingly, thus avoiding accidents.

CUT-OUT.—C. W. SNYDER, Hudson, N. Y. The object of the invention is to provide means for automatically breaking the circuit through the light some time after an element of the cut-out has been manually operated, or, in other words, to permit the burning of a dim light for a predetermined time after turning the key to break the direct current from the main circuit through the filament. It relates to improvements in cut-out lights and other electrical devices.

Of Interest to Farmers.

STOCK-FEEDER.—J. J. DOWELL, San Francisco, Cal. Mr. Dowell's invention relates to stock-feeders, his more particular object being to produce a feeder in which the supply of feed is to some extent under the control of the animals to be fed. The inventor finds that animals—such, for instance, as horses—when fed by either of certain devices of the feeder soon learn to manipulate the agitators, so as to control the supply of food at will.

CORN-SILKING MACHINE.—L. S. FLECKENSTEIN, Easton, Md. This improved machine combines the two very important qualities of a movement of a screen-holder which effects the rapid passage of the corn through the screens and adaptation for convenient and quick removal of the screens individually while the machine is in operation. Removing and reinsertion of a screen occupies but a few moments. Parts of machine contacting with the corn are preferably galvanized so that they can be easily kept sweet and clean.

THRESHING AND STRAW-CUTTING MACHINE.—C. J. SMITH, Durham, Canada. The concave is dispensed with in this threshing machine. The cylinder is provided with diametrically-opposing diagonally located knives which act in conjunction with ledger-plates and feed-rollers behind the plates and the cylinder not only serves to thresh out the grain, but also to cut the straw in fine particles. Means are provided for separating the chopped straw from the grain and for blowing the chopped straw from the machine. One feed-roller automatically moves to or fro from the other, according to thickness of the bed or spread of material, and means provide for controlling the speed of the feed-rollers. The teeth never beat through more than two inches before the straw is cut off. While it takes twelve to fifteen men to operate a long straw thresher, Mr. Smith's invention requires but seven.

Of General Interest.

NUT-LOCK. — J. W. GRAEME, Washington, D. C. The invention is an improvement in nut-locks, and particularly in that class of nut-locks in which a pawl carried by the nut engages with an abutment. The invention may be applied to right or left-hand nuts, the change necessitating merely a reversal of the pawl.

GATE-HINGE.—H. MEINECKE, Tomah, Wis. In this case the invention is an improvement in hinges for gates and similar heavy objects wherein the weight of the gate or the like exerts a heavy strain upon the hinge; and one of the objects of the present invention is to provide a novel construction whereby the weight of the gate will operate to tighten the hinge in place.

ART OF MAKING PERFORATED PAPER.—F. J. MOTZ, New York, N. Y. This is a new method particularly intended to produce the perforated sheets used in musical instruments, but it is useful in other connections. Heretofore perforations have been made by cutting or punching them in paper, which involves a loss of paper, an extra expenditure of time and labor, and also materially weakens the sheets. The inventor comprehends forming openings in the paper stock while the same is yet in pulp-like form, and subsequently the stock thus orificed is converted into paper, producing the perforated sheet.

CONVEYER.—A. L. LAUBENSTEIN, Ashland, Pa. This conveyer is such as used for loading coal, iron ore, dirt, and similar material. In practice these conveyers usually comprise endless chains, which are continuously driven and have buckets or blades attached to them for advancing the material. The object is to produce a chain-link of simple construction for such conveyer especially adapted for attachment to the bucket.

DAM.—J. L. HOLMES, Butte, Mont. The invention relates to metal dams, such as shown and described in the application for Letters Patent of the United States, formerly filed by Mr. Holmes. The present object is to provide a dam for rivers and other waterways to permit of utilizing dammed-up water for use in power plants, for irrigation, and other purposes, the dam being arranged to prevent or retard the corrosive action of water and air on the metalwork of the dam, to properly brace the dam and hold it against tipping over in an upstream direction when water is withdrawn, and to protect it against ice, logs, and other floating matter.

CONCENTERING COUPLING DEVICE FOR PIPE OR CASING SECTIONS.—J. W. HAYS, Woodsfield, Ohio. The invention has reference to means for concentering tubular members when coupling together adjacent ends thereof; and one of the principal objects is to overcome many former disadvantages and objections and to provide means whereby the adjacent ends of pipe-sections to be coupled together may be concentered with relation to each other, thereby enabling the two sections of pipe to be quickly joined together for use for various purposes.

FURNACE FOR TREATING SHEET IRON AND STEEL.—H. H. GOODSELL, Leechburg, Pa. The present invention has reference to furnaces for treating sheet iron and steel, but more particularly to an improved type of furnace which may be used advantageously in connection with the process described in an allowed application formerly filed by Mr. Goodsell. In this improvement the process is an annealing as well as an oxidizing process.

METALLOPHONE.—F. R. GOOLMAN, Binghamton, N. Y. One purpose of the inventor is to provide an instrument in which the sound-producing devices consist of metal scale-bars operated upon by hammers and to so construct it that the hammers will be pneumatically controlled and the pneumatic devices brought into action by connection with a suitable electric motor and to provide means for automatically starting the motor when a coin is dropped, and automatically stopping the instrument when the end of a piece of music or its repeat is reached.

Machines and Mechanical Devices.

BINDING-MACHINE FOR WAY-BILLS, ETC.—C. F. MCBEE, Athens, Ohio. More especially this invention has reference to machines for binding together in book form any desired number of paper or other sheets, as way-bills, checks, or the like, and one of the principal objects thereof is to overcome disadvantages and objections common to many other machines devised for similar purposes. The machine may be made of any desired size, and the height of the pile or stacks of sheets to be bound together may be varied within the limits thereof. A leading eastern railroad company is now using the machine at some of its stations.

Prime Movers and Their Accessories.

SPARK-TIMING DEVICE.—G. A. ELSASSER, JR., and P. M. ELSASSER, Philadelphia, Pa. The invention pertains to a device for timing the electric igniting spark in gas-engines and the like. The objects are to secure in devices of this character simplicity of operation and construction, accuracy in timing, accurate and simple adjustment, small cost of production, compactness, wide range of speeds, and ready adaptability for all kinds of gas, gasoline, and all other explosion engines employing the electric jump-spark for the ignition of gas.

FEED-WATER HEATER.—B. E. EASTBURN and F. L. TAPIA, Montgomery, Ala. The invention consists in a means for introducing boiler-steam into the feed-water between the injector or other means for forcing the feed-water and point of entry of the feed-water into the boiler. This means consists of a pipe leading from the steam-dome to a fitting interposed in the feed-water pipe, and having a valve-controlled connection for the pipe from the steam-dome, so that upon opening the valve of said connection steam is admitted from the dome into the feed-water, serving to raise temperature thereof, and to accelerate its movement into the boiler.

THROTTLE-VALVE.—H. M. LOFTON, Atlanta, Ga. The invention has for an object the provision of a construction whereby a portion of the fed steam or other power fluid may be admitted to a desired point in advance of the passage of the main supply of such power fluid to its point of operation. An advantage is, that by graduating the amount of steam passing through V-shaped ports the main-valve seats are not cut by what is known as "wire-drawn steam," as is the case where an ordinary disk valve is used to regulate the amount of steam fed.

OIL-CONDUCTOR.—J. C. JONES, Tucumcari, New Mex. This improvement pertains to feed devices for oil-conveying tubes, and the object is to provide a device that will insure an even and steady flow of oil through a pipe leading from a lubricator to a chamber subject to a variation in pressure—such, for instance, as the steam-chest of a locomotive or engine in which the changes of pressure are not only frequent and constant but often very great.

ROTARY ENGINE.—L. VAN D. SUTTON, West Newton, Pa. Mr. Sutton's invention is an improvement particularly in that class of rotary engines represented by his former patent, and in which cylinders consisting of annular tubes are arranged close together at their lower ends and diverge toward their upper ends, so that they afford space between them for the operation of a carrier which co-operates with pistons in the form of long curved cylindrical bodies and operating in the cylinders.

SLIDE-VALVE FOR STEAM-ENGINES.—L. J. W. H. GIFFHORN, deceased, Spotswood, N. J.; EMILY GIFFHORN, Administratrix. The invention pertains to improvements in the slide-valve of steam-engines; and the objects are to remove or counteract the well-known defects of the slide-valve as it now exists—namely, the unevenness of the valve and the valve-seat resulting from wear—and thereby to prevent and remove the effects caused by the unevenness, such as loss of steam, coal, or other fuel, machinery and money. The slide-valve is self-regrinding.

STEAM-BOILER.—C. A. STURM, Castlerock, Wash. In this patent the object of the inventor is to provide a new and improved steam-boiler which is simple and durable in construction, cheap to manufacture, and arranged to utilize the burning fuel to the fullest advantage and with a view to generate steam quickly and very economically.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**
MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 7151.—For manufacturers of springs wound by a key and run for five or ten minutes.

For hoisting engines. J. S. Mundy, Newark, N. J.

Inquiry No. 7152.—For manufacturers of low pressure condensing engines of 4 to 10 h. p., suitable for driving a ventilating fan in public school buildings.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 7153.—For manufacturers of machine for cutting tub butter into one pound prints.

2d-hand machinery. Walsh's Sons & Co., Newark, N.J.

Inquiry No. 7154.—For manufacturers of chain-making machinery, suitable for modern chain works.

Perforated Metals, Harrington & King Perforating Co., Chicago.

Inquiry No. 7155.—For manufacturers of colored marble for decorative purposes.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 7156.—For manufacturers of machine for burning impressions on wood and leather.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 7157.—For manufacturers of small toys.

Marketers of meritorious inventions and specialties throughout the world. Tatem Mfg. Co., Buffalo, N. Y.

Inquiry No. 7158.—For manufacturers of roller skates.

I sell patents. To buy them on anything, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 7159.—For manufacturers of endless canvas aprons.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

Inquiry No. 7160.—For manufacturers of bakery machinery.

Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

Inquiry No. 7161.—For manufacturers of chain dish-rags.

Sheet metal, any kind, cut, formed any shape. Die-making, wire forming, embossing, lettering, stamping-punching. Metal Stamping Co., Niagara Falls, N. Y.

Inquiry No. 7162.—For manufacturers of "Yale Metal Polish."

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, wood fiber machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 7163.—Wanted, address of Sterling Water Tube Boiler Co.

Absolute privacy for inventors and experimenting. A well-equipped private laboratory can be rented on moderate terms from the Electrical Testing Laboratories, 548 East 80th St., New York. Write to-day.

Inquiry No. 7164.—For manufacturers of apparatus for Turkish, Russian, vapor, electric and spray baths.

WANTED.—Thoroughly experienced practical ice machine—and Corliss engine salesman for concern in middle West. State experience, age and salary expected.
Address Salesman, Box 773 N. Y.

Inquiry No. 7165.—For manufacturers of machinery for making muriatic or hydrochloric acid.

PATENTS ON DREDGES AND DREDGING MACHINERY FOR SALE.—By reason of the death of Ralph R. Osgood, valuable patents, having a long term to run, are offered for sale. For terms communicate with
The Albany Trust Company, Executor,
Albany, N. Y.

Inquiry No. 7166.—For manufacturers of flat-headed tacks.

Inquiry No. 7167.—For manufacturers of steel strings for musical instruments.

Inquiry No. 7168.—For manufacturers of gas-making machines.

Inquiry No. 7169.—For manufacturers of glass, cheap watches, jewelry and cheap phonographs; also address of jobbers who supply mail order firms.

Inquiry No. 7170.—Wanted, address of company sinking deep wells.

Inquiry No. 7171.—For manufacturers of small gears, suitable for small clocks.

Inquiry No. 7172.—For manufacturers of electrically welded wire hoops or bands for wooden pails or other utensils.

Inquiry No. 7173.—Wanted, address of any who are experimenting in new insulators or substitute for rubber.

Inquiry No. 7174.—For manufacturers of novelties and patented articles, such as shear sharpeners, etc.

Inquiry No. 7175.—For manufacturers of differential plyers.

Inquiry No. 7176.—For manufacturers of dish-washers for ordinary household use.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.
References to former articles or answers should give date of paper and page or number of question.
Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.
Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.
Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.
Scientific American Supplements referred to may be had at the office. Price 10 cents each.
Books referred to promptly supplied on receipt of price.
Minerals sent for examination should be distinctly marked or labeled.

(9730) E. H. B. asks: Can you tell me magnetic variation for North Dakota for this year and following three? A. The magnetic declination for North Dakota is given in the tables published by the United States Geodetic and Coast Survey for 1902 as from 10 deg. 32 min. E. at Grand Forks to 16 deg. 55 min. E. on the Canada boundary in 103 deg. 30 min. west longitude. There is a large difference between the eastern and western parts of the State. The rate of change for the State is 4 min. decrease per annum. The tables to which we refer give the variation at many places in the State. As you do not give your county, we cannot give more definite information. If you are in Lamoure County, the variation was 12 deg. 24 min. in 1902.

(9731) G. J. B. writes: In your Notes and Queries of April 1, 1905 (No. 9594), you say that the curvation of the earth is 8 inches for one mile and 32 for two miles. This is right (approximately) when running an east-and-west level but ceases to be true when running north and south, or else the doctrine that the north-and-south axis of the earth is 26 miles shorter than the east-and-west axis must be false. It is easily evident that if you run a level starting from a given point on the equator and running west through 90 deg. of arc with 8 inches allowance for each mile and should then start at the same place on the equator and run north through 90 deg. of arc, you would come out up in the air at the north pole. This would be equally true if you run the same levels with equal fore and back sights. A true instrumental level is a series of short chords whose ends are equidistant from the center of the earth, and paradoxical as it may seem, a true level is a true circle. It is literally true that the Mississippi River runs up hill, else its mouth could not be farther from the earth's center than the source. It is also true that no river of the same levels could exist in an east and west course, unless its source was underground and it should rise gradually to the surface. The levels of the Amazon River are most decidedly different from the Mississippi. A. Definitions are the safeguards of a discussion. Unless words are used in the same sense by both sides to an argument a discussion is not profitable. And when you state that "an east-and-west level is not the same as a north-and-south level" and that "the Mississippi River literally runs up hill" it is evident that the terms "level" and "up hill" need definition. We cannot agree to either expression in the sense in which the dictionary requires us to use terms. If we define level, probably the term up hill will take care of itself, since it must be defined as departing from a level by rising above it. The Century Dictionary, which is usually considered as good authority, defines a level as "an imaginary surface everywhere perpendicular to the plumb line, or line of gravity, so that it might be the surface of a liquid at rest. Every such surface is approximately that of an oblate spheroid, as the sea level, for example, is." This seems very plain. We cannot think that anyone would maintain that the sea from the latitude of the source of the Mississippi to that of its mouth is uphill, yet if the river flows uphill surely the sea also flows uphill, and a ship sails uphill in the northern hemisphere here, as it sails south. A level is not a surface equidistant from the center of the earth, and is never defined as such. That would not be a level. Water would not lie upon such a surface, and a level run north and south does not differ from one run east and west. It is nonsense to say that a level is run differently in one direction from what is done in another. The only difference is that centrifugal force acts to modify the level north and south, but the liquid of a level, the ship on the sea and the waters of the flowing rivers, all are sensible to the action of this force all the time and everywhere. A level is the surface of still water, and the water of a south-flowing river at its source in the northern hemisphere is above the level of its mouth, and the water of this river flows down hill from its source to its mouth.

(9732) W. C. W. asks: Are there at present any annunciators which have one wire only running from the push buttons to the indicator? A. We do not see how there can be any possible way to wire for several pushes on an annunciator so as to ring from several

places by a single line wire, as shown in your sketch. There is none on the market at present which ring in this way. One wire must be carried entirely around the circuit, and a wire must also go from each push to the annunciator.

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Cloth rubbing and glazing machine, H. Simonin 796,462
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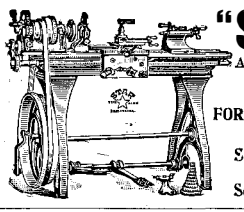

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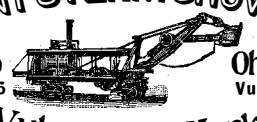

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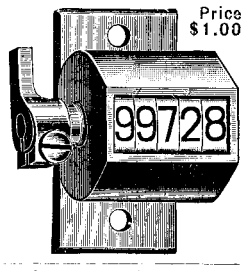

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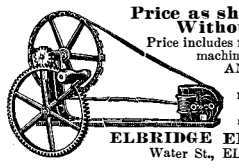

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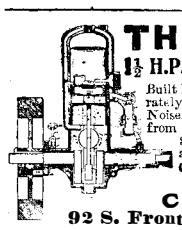

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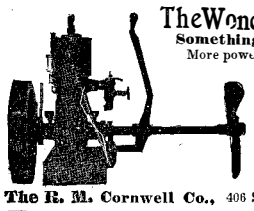

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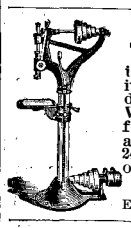

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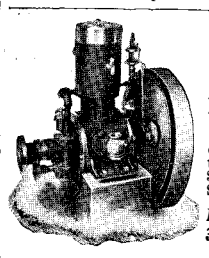

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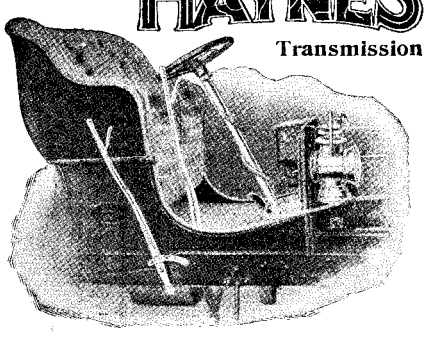

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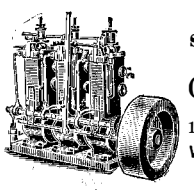

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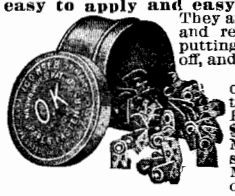

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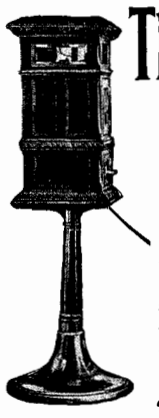

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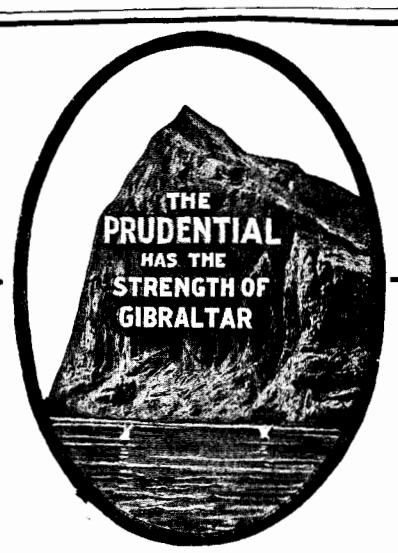

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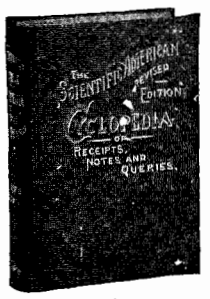

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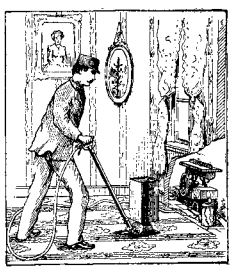

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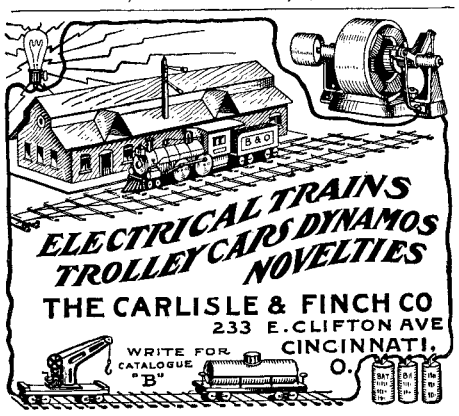

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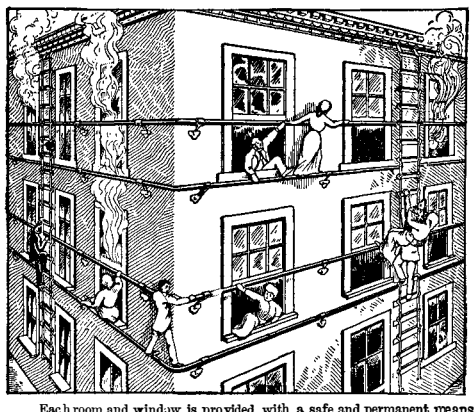

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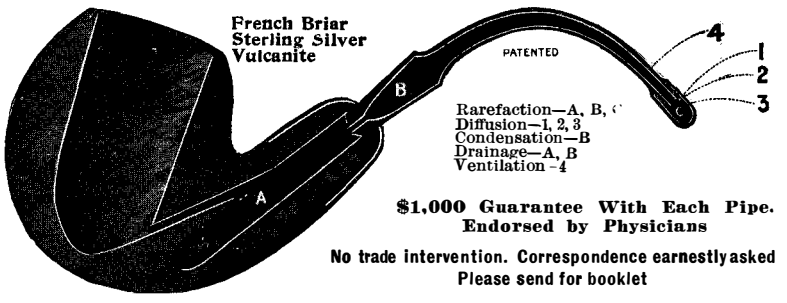

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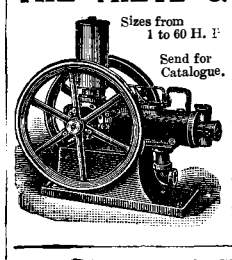

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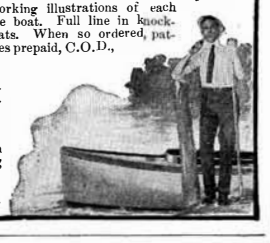

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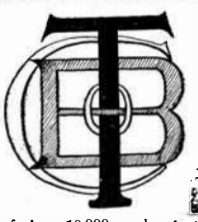

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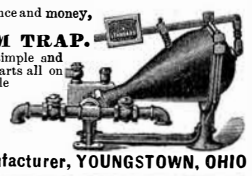

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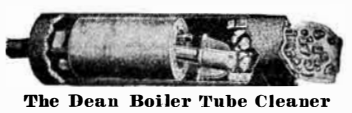

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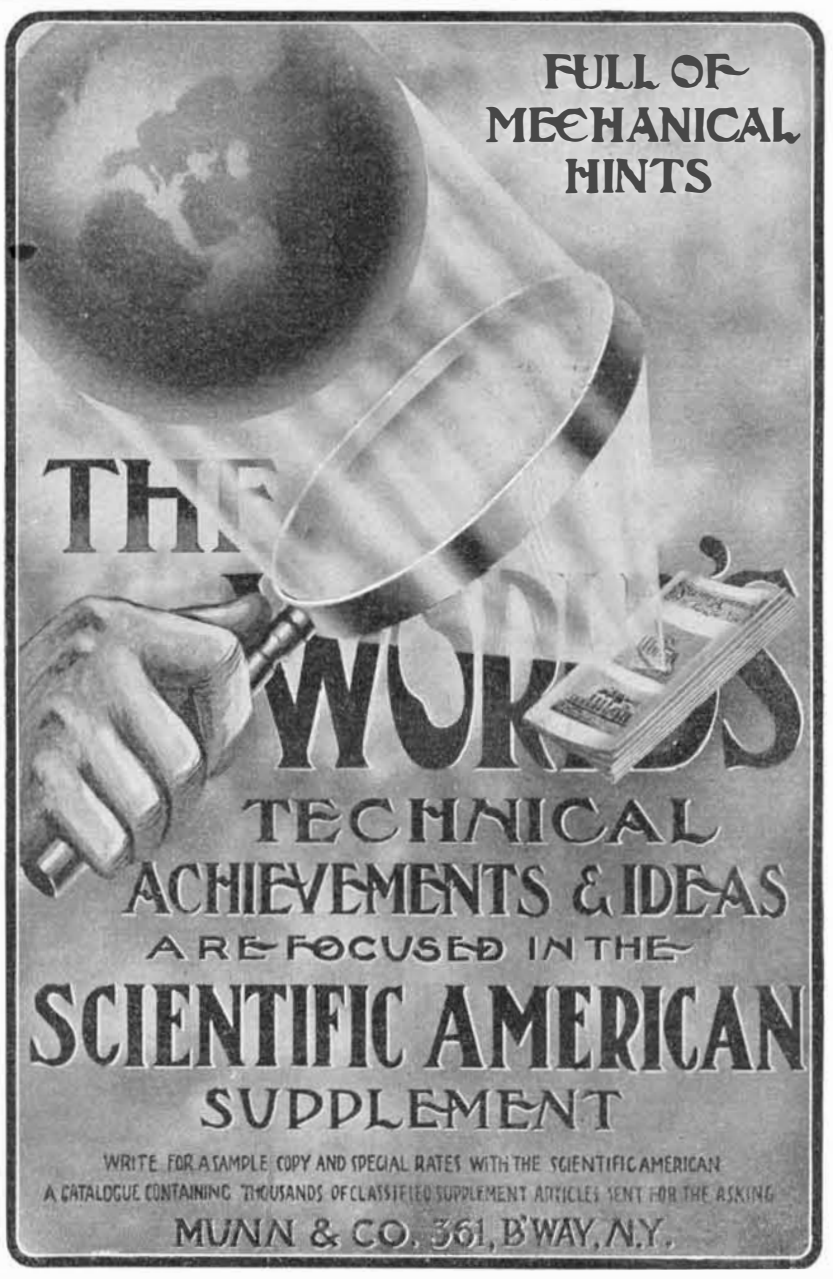
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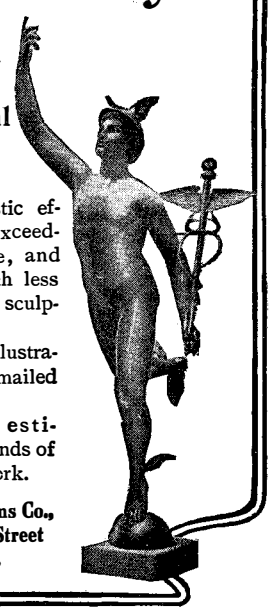

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Wood fillers, primers, and paints, Bridgeport Wood Finishing Company	45,213
Wool wadding, M. A. Evans.	45,091

LABELS.

"America," for mantles, Liberty Inc. Light Co.	12,315
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"Apex Brand," for renovated butter, B. D. Catlin	12,308
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"Ma-Po-Lo," for medicine, Ma-Po-Lo Medicine Co.	12,310
"Madonna Ao 1851," for eau-de cologne, J. M. Forina zur Madonna	12,314
"Neenah," for cigars, Kohn Bros. & Co.	12,304
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"S. B. Clark's Tourist Lunch Biscuit," for biscuits, H. E. Clark	12,307
"Veribest," for whisky, M. Essig	12,303

PRINTS.

"Bohemian Brew," for beer, Jackson Brewing Co.	1,395
"What the Doctor Says," for beer, George Wiedemann Brewing Company	1,394

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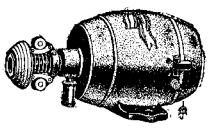

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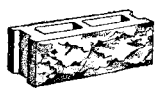

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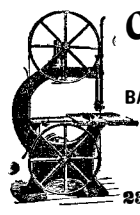

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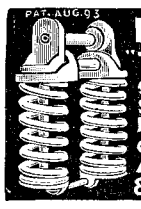

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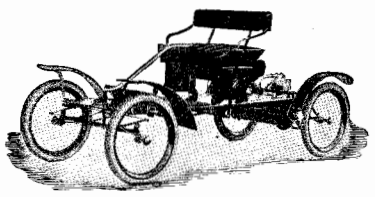

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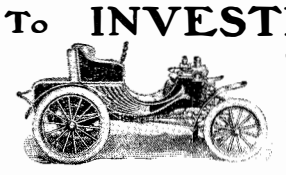

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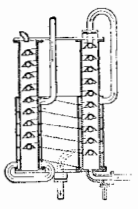

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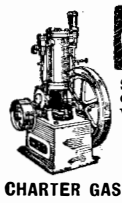

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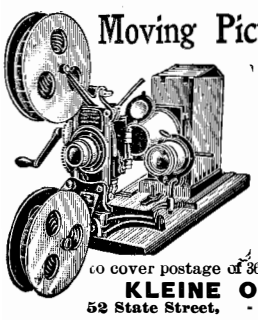

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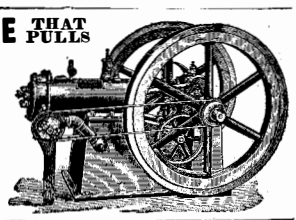

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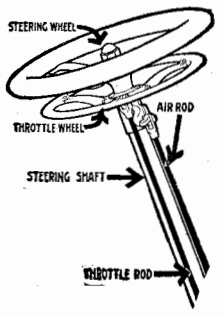

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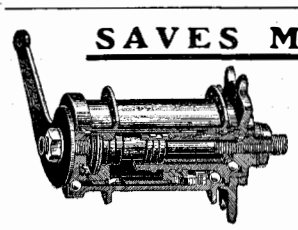

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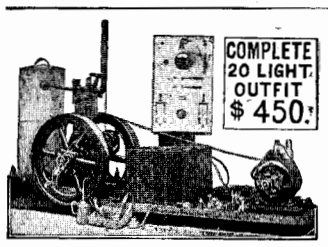

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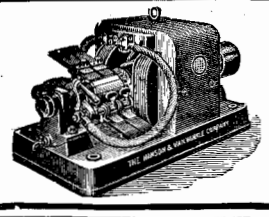

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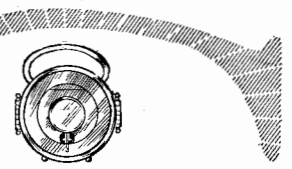

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